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ART. I. *On the Theory of the Dead Escapement, and the reducing it to practice for Clocks with Seconds and longer Pendulums. By* B. L. VULLIAMY, Clock-maker to the King.

STRONGLY impressed with the great practical superiority of the dead escapement, when properly constructed and executed, over every other for clocks with seconds or longer pendulums, I have taken much pains to ascertain whether any rule of general application has been laid down by different authors who have written on the theory and practice of clock work, to determine the distance between the center of the escapement wheel, and the center of action of the pallets, which, as far as relates to the theory of the escapement, is of the utmost importance, and not the less so as regards reducing that theory to practice; and generally for determining the relative proportion of the parts of the dead escapement as usually made for clocks. I regret to add, that my inquiries have not been attended with the success the importance of the subject, (as connected with the accurate measurement of time by clocks,) had induced me to expect.

The merit of the invention of the dead escapement is, I believe, unquestionably due to that celebrated clock-maker, George Graham, F.R.S., but unfortunately he left no written description of it that

I am aware of, and the chief mention I have found of the principle of his escapement is in the works of the French authors *.

Thiout l'ainé, in his *Traité de l'Horlogerie*, 4to, Paris, 1741, on the subject of Escapements, Vol. 1st, page 103, thus expresses himself:—"Fig. 19, (Plate 43, Vol. 1st,) is a dead escapement for clocks, as made by Mr. Graham, clock-maker, of London. The rule I have discovered for making it, and which I apprehend to be a good one, is to place the center of the anchor at the distance of one diameter of the wheel from the wheel," (that is a diameter and a half of the wheel from its center,) "as shewn in the figure. The center of the anchor must be placed upon the perpendicular line, passing through the center of the wheel, and the wheel cut into thirty teeth, beginning from the above-mentioned perpendicular line; and the teeth which suit the best must be chosen to determine the place of an arc drawn from the center of the anchor upon which to form the pallets, which must be so made that the seconds hand does not recoil." Here follows a description of the action of the escapement.

From the above it is evident, that M. Thiout's knowledge of this escapement was very limited.

The subject of the dead escapement is entered into at some length by F. Berthoud, F.R.S., of Paris, the author of several horological works. In his *Essai sur l'Horlogerie*, 4to, Paris, 1763, Tom. 1, Première Partie, Chap. xxi. No. 397, page 129, he thus

* I fully expected some account of this escapement in the Transactions of the Royal Society, of which Mr. Graham was a member: but by reference to the Index of the transactions, there is no mention of Clock Escapements; at which I am the more surprised, as there is a communication from Mr. Graham on the subject of his invention of the Mercurial Pendulum, and the measuring the lengths of pendulums at different places. Mr. Graham was the immediate successor to Tompion, and the art of Clock and Watch-making is so much indebted to him for its advancement, that I consider it due to his memory to insert the following memorandum.

He was born in 1675, was elected an Assistant of the Court of the Company of Clock-makers of the city of London the 18th April, 1716, and served the office of Master of the Company 1721 and 22; was elected a Fellow of the Royal Society the 9th March, 1728, and died the 16th November, 1751. His remains were interred in the aisle of Wesminster Abbey.

expresses himself: "397. The distance between the center of the anchor of the escapement and the center of the wheel, depends upon the arc the pendulum is required to vibrate *; if it is to describe large arcs of 10°, for example, then the center of the anchor must be at B." See Fig. 1, Plate I. (Berthoud, Fig. 8, Plate XV.)

398. "But if, on the contrary, it is to describe a short arc, of 1° for example, the center must be at *a*. See Fig. 2, Plate I. (Berthoud, Fig. 10, Plate XV.) at the distance of about a diameter and a half of the wheel A from the center of the wheel †; observing in

* This is not perfectly well expressed, as by the arc the pendulum is required to vibrate, might in this case mean the arc the pendulum must describe to enable the pallets to escape; or, in other words, the quantity the pendulum is led by the action of the wheel upon the inclined planes of the pallets, and not the total arc of the vibration of the pendulum; (at Nos. 399 and 400, M. Berthoud describes the difference between the total arc of vibration of the pendulum, and the arc led by the action of the wheel upon the pallets,) neither is this a correct statement, for the quantity the pendulum is led by the action of the wheel upon the pallets, depends upon the angle of lead of the pallets, or the length of their inclined planes; as well as upon the distance between the center of action of the pallets and center of the wheel, and consequent number of teeth the pallets take over. In illustration of this, (see Fig. 3. Plate II.) to the same wheel are applied two pairs of pallets, which, taking over a different number of teeth of the Wheel, are consequently at different distances from the center of the wheel; and yet from the difference of the angle of lead of the pallets, the pendulum will be led an equal quantity of the action of the wheel upon either pair of pallets; the difference between the angles of lead of the pallets compensating for the difference between the distances at which each pair of pallets is placed from the wheel.

In the figure the four triangles, B A C, D A E, F W G, and H W I, which express the angles of lead of the pallets, are drawn equal to one another, and equal to the triangles K A L and N W M, also equal to one another, which shew the quantity the pendulum is led by the action of the two pair of pallets, on each side of the perpendicular line A X.

† I believe that Mr. Graham, Mr. Shelton, who worked with him, and most of the clock-makers of that period, who trod in the footsteps of Mr. Graham in the construction of their seconds pendulum clocks, (the scape wheels of which were necessarily cut into thirty teeth,) made their pallets take over eleven, twelve and thirteen teeth of the wheel; and the distance between

both cases, that the opening of the compass that describes the rests, or circular faces of the pallets, is such that drawing a line from the point 5, Fig. 1, Plate I, through the center B of the anchor, and drawing upon its extremity 5 a line *z* A that shall pass through the center A, of the wheel; these lines are so situated that the line *z* A shall be perpendicular to the line 5 B *; and by the same rule, if the anchor is placed at *g*, the pallets, or inclined planes, of the anchor should act upon the wheel at the points *e f*; this understood, the portions of the circles 1 C, 3 D, Fig. 2, Plate I. (M. Berthoud tranfers his description to Fig. 10 of his work,) must be drawn of the same radius *a* C; and in the same manner 2, 5, and 6, 4, taking care that the space, or thickness, C 5, 6 D, between these portions of circles, is a little less than half the interval between the teeth of the wheel."

"Now, to determine the inclination of the planes, from the center *a*, Fig. 2, draw the straight lines *a f* and *a g*, forming the angle *f a g*, being half the angle the pendulum is required to be led †; through the points 2 and 1, where these lines intersect the arcs 2, 5, and 1, C, draw the straight line 2, 1, which gives the inclined plane 2, 1, by a similar operation the inclined plane of the

the centers was one diameter of the wheel in the case of taking over eleven teeth; about one and a half diameter in the case of taking over thirteen teeth; and between one diameter and one diameter and a half in the case of taking over twelve teeth. The French clock-makers, who copied Graham's escapement, followed nearly the same rule.

* (See Fig. 1. Plate I.) In the case of the anchor, whose center of motion is at B, M. Berthoud determines the center of action of his pallets by the intersection of two tangents drawn from the points where the circle of the inner rest of the pallets prolonged intersects the circle that circumscribes the wheel. By this mode the two centers are nearer together than they would have been, had he determined their distance by tangents drawn from the points where the circle of the outer rest intersects the same circle.

That the points found by the intersection of tangents drawn from either of these points is not the proper center of action of the pallets, will be shewn hereafter,—in the one case the centers are too far apart; in the other case they are too near together.

† See note, page 3.

other pallet is obtained. There are several other practical methods which are easy of application, but difficult to explain."

And again, at Nos. 1324 and 1325, page 449, (in what follows the 'scape wheel is supposed made, and the original text is abridged, such parts only being translated as immediately relate to the laying down of the lines of the escapement,) " To draw the anchor piece of the escapement," (Berthoud here supposes the drawing to be made upon a brass plate, and the distance between the centers already determined,) " the distance on the pillar plate between the center of the scape wheel and the center of the verge of the pallets must be taken * : from the center *a* of the anchor, see Fig. 3, Plate I. (Berthoud, Vol. ii. Plate XXIII. Fig. 3; part of Berthoud's figure is omitted, no more being drawn than immediately relates to the text,) the line *a b* must be drawn just to touch the circumference, *b c*, of the wheel; if from the point *b*, where the two lines touch each other, the radius B *b* is drawn, it will be perpendicular to *b a* (as may be geometrically demonstrated,) and conformable to mechanical principles the action of the wheel upon the pallets should be at the point *b*; consequently, *a b* is the length to be given to the arm of the anchor, to enable the wheel to act upon the pallets in the most favourable manner possible."

1326. " Place the wheel in the plate with its center on the point B, then place one of the points of a pair of compasses on the center *a* of the pallets, open the compasses to the quantity *a c*, and turn the wheel on the center B, until the front of one of its teeth meets the other point of the compasses on the circle of the wheel at *b*; that done, keep the wheel immoveable, transport the

* From this it would appear, that M. Berthoud's plan is to determine the distance of the two centers from each other on the plate of the clock, and then to adopt his escapement to those distances; which, as the number of the teeth of the wheel is regulated by the length of the pendulum, to preserve the angles B 5 A, B 6 A, *g e* A, and *g f* A, Fig. 1. Plate I. right angles, can only be done by making the pallets take over a greater or lesser number of teeth, or, if necessary, by altering the size of the wheel; or, if this cannot be done for want of room or any other cause, then, and quite contrary to his leading principle, the angles B 5 A and B 6 A, &c., must be increased or diminished.

other point of the compasses to the other side, and see if it will reach the back of the point of another tooth at *c*: if it does not, the opening of the compasses must be varied until it reaches from the center *a*, at the same opening the points of the two teeth, the nearest to the points *c* and *b*: draw the portions of circles *b t*, *c p*, which will represent two of the circular faces of the pallets*".

1327. "To find the other two circular faces, the opening of the compasses must be altered in such a manner, that the teeth of the wheel having advanced a quantity equal to half the interval between them, they pass a second portion of a circle drawn from the same center *a*, and intersecting the circle of the wheel; but as that may equally be done by opening or closing the compasses, a quantity equal to the space between two teeth, it is preferable to use that of the two openings which will occasion the distance of the lines from the center to vary the least from the points *c* and *b*, which points are to be varied from as little as possible. That done, trace the other two faces of the pallets *d s* and *e g*†, which are here by preference drawn within the others, to diminish the space the anchor has to move, and, consequently, the friction of the pallets. In this manner are described the four circular faces of the two pallets, placed in such a manner, as to let the teeth of the wheel alternately escape as the pallets approach and recede from the center of the wheel by the action of the pendulum."

1328. "The length of the pallets is regulated by the quantity of the angle of lead that is to be given to the escapement, which we will here suppose of 5° on each side, or thereabouts."

1329. (This part is very much abridged in the translation.) "To describe the angle of escapement, prolong the line *a b*, to *f*. See Fig. 3, Plate I, and draw the angle *f a g* of 5°, the point *d*, where the line *a g* intersects the inner circular face of the pallet, determines the length of the pallet; for the wheel in passing the pallet, causes it by its action on the inclined plane, to describe an

* This is not correct, because *c p*, Fig. 3. Plate I., is not a face of the pallet.

† This again is incorrect; *d S*, Fig. 3. Plate I, is not a face of the pallet, and cannot be considered as such.

angle of 5° to have the inclined plane, draw the line *d b* passing through the points *d* and *b* where the straight lines *a f* and *a g* which form the angle *g a f* intersect the portions of circles *d s* and *b t*."

1330. "To draw the inclined plane *c e*, it is to be observed, that as the pallet *d b* is drawn 5° within the circle of the wheel, it follows that the pallet *c* must be situated without the same circle, and ready to come into action as the other pallet escapes from the wheel. Prolong the line *a c* to *h*, and draw the angle *h a i* of 5°, which will determine the measure of the inclined plane *c e;* it only then remains to draw the line *c e*, which passes through the points *c* and *e*, where the straight lines *a h* and *a i* intersect the portions of circles *c p* and *e q:* thus will be given the inclined plane which is to terminate the pallet, and so situated, that when the tooth *C* shall have led the pallet without the circle of the wheel, a quantity equal to an angle of 5°, the pallet *c e* shall also be led an angle of 5°, and within the wheel; consequently, when the tooth *r* shall have led the pallet to escape, the pallet *c* will have described an angle of 5°, whence it follows, that the total lead of the escapement will be 10°*".

* This is a mistake; the total quantity the pendulum is led being an angle equal to the angle of lead of either of the pallets; (it is supposed that the angles of the two pallets are equal to one another, as they ought to be,) and the pendulum is led nearly an equal angle, ascending and descending on each side of zero, (or the perpendicular line on the degree plate,) by each pallet alternately; but the advance of the wheel, and consequently the friction upon the inclined planes of the pallets, is not uniform during the ascending and descending of the pendulum at each vibration, but exists upon a greater proportion of, and is consequently greater upon, the pallets as the pendulum ascends than as it descends; for, supposing the inclined planes of the pallets divided at that point which the extremity of the tooth of the scape wheel has reached when the pendulum is perpendicular, the portion of the inclined planes the tooth of the wheel acts upon, as the pendulum descends, is less than the portion acted upon as the pendulum ascends.

It is possible to make the inclined planes of the pallets so long, that the angle of the total vibration of the pendulum will not exceed the angle of lead of the pallets, in which case it will be visible that the total angle the pendulum is led is only equal to the angle of one of the pallets.

M. Berthoud has fallen into the same error at No. 399.

To

1331. "The escapement thus drawn will be a dead escapement, because it is formed of portions of circles concentric to the point A (396) but," &c.

To illustrate as much of the above as refers to the irregularity of the friction upon the pallets, suppose Fig. 1. Plate II. the pendulum at rest, and perpendicular upon the line X W, bisecting the angle Y X Z, (which angle is equal to the angles B X P and D X Q of lead of the pallets,) and the lines A B and C D the inclined planes of the pallets; the dotted lines E E and G H will represent the lines of the inclined planes, when the pendulum subtending the line X Z is led to the extremity of the lead one way; and the dotted lines I K and L M the inclined planes when the pendulum subtending the line X Y, is at the extremity of the lead in the other dissection, (it cannot be too often repeated that the angle of lead must not be compounded with the angle of vibration,) and the points N and O, where a supposed circle circumscribing the points of the teeth of the wheel intersects the inclined planes A B and C D, are the points upon one of which (determined by the pallet from which the wheel has last escaped) the wheel will be in contact with the pallet, when the pendulum having advanced half the angle of lead subtends the perpendicular line X W. Now it is visible that the portions N A and O D of the lines A B and C D, which are the parts of those lines the teeth of the wheel act upon when the pendulum ascends, are greater than the lines N B and O C, which are the portions the teeth of the wheel act upon when the pendulum descends; consequently, the velocity with which the wheel advances is not equal during equal portions of the lead of both pallets.

By altering the shape of the inclined planes of the pallets from straight lines to portions of circles, the advance of the wheel may be made nearly proportional to the advance of the pendulum. Suppose, Fig. 1. Plate II., the pendulum to subtend the perpendicular line X W, and consequently to have vibrated half the angle it is led, and the inclined plane of the pallet Æ, instead of being the straight line D C, to be a portion D T C of a circle, passing through the three points D, S, (where the radius R V bisects the arc M G of a supposed circle circumscribing the wheel,) and C; the consequence resulting from giving this shape to the pallets will be, that the wheel will have advanced to the point S half its total advance, and have acted upon very nearly half the surface of the pallet, when the pendulum has vibrated half the angle it is led; for the portion C S of the circular face of the pallet upon which the wheel has acted during its advance from the point G to the point S, is less than the portion S D of the pallet upon which it must act during its advance from S to D, by the quantity S T; which difference between the arcs C S and S D is very trifling when compared with the difference between the straight lines C O and O D, which form the inclined plane C D.

The

The late Mr. Cumming, F. R. S. E., in his *Elements of Clock and Watch Work*, London, 1766, page 43, No. 176, states, that Graham made his pallets take over twelve teeth. In his Plate II., in which he represents the dead escapement drawn very large, and in detail, Mr. Cumming places the centers at the distance of exactly one diameter of the wheel apart, and makes the pallets take over eleven teeth :

The same effect takes place in the pallet AB, but, from the relative situation of the parts, in a much less degree; the circular face of the pallet requiring to be a portion of a much larger circle : and here it is worthy of notice, that the faces of the two pallets being portions of different circles, the one is, in fact, a longer line than the other, and consequently with circular faces as just described, there is more friction on one pallet than on the other; and more on both than when the acting faces are straight lines.

The proportional advance of the wheel and pallets was probably considered by Mons. L. Berthoud, (chronometer-maker to the French Navy during the period of the Republic,) of great importance in the case of the dead anchor escapement when applied to watches; he having given this shape to the pallets of some of his box marine chronometers, that I have had an opportunity of seeing.

The friction is also unequal upon the rests of the pallets, without regard to the shape of the inclined planes, whether straight or curved : for the arc of vibration on each side of zero on the degree plate must necessarily subtend equal angles, and the angles of lead on each side of zero being also equal, it necessarily follows that the angles of rest must be equal; but the rests of the pallets being at unequal distances from their center of motion of a quantity equal to the thickness of the pallet, it also follows that, though the arcs which subtend the angles of rest subtend equal angles, yet that one of them must necessarily be larger than t h other, being a portion of a larger circle; and consequently the friction greater upon the one than upon the other; the difference, however, is very small, and this is an evil that from the construction cannot be avoided.

It is scarcely necessary to add, that for the clock to be in beat, it is requisite not only that the angles the pendulum is led should be equal, but that the angles of rest on the circular faces of the pallets should also be equal; otherwise the total angles of vibration on each side of zero on the degree plate, (which represents the perpendicular line when the pendulum is at rest,) will not be equal, and, consequently, not be performed in equal times. The above observations will, I believe, be found to be of universal application in this construction of the dead escapement.

For further illustration on the subject of the angle of lead, see "Astronomical Observations," by the Rev. Wm. Ludlam, 4to., Cambridge, 1769, note, page 86.

from the center of the wheel considerably less than a quantity equal to one diameter of the wheel; and that when the pallets take over twelve teeth, the distance is considerably greater than one diameter of the wheel. Also by reference to Fig. 5, that when the pallets take over eleven teeth, the distance is exactly (or very nearly so) one diameter; and when they take over thirteen teeth, a little more than one and a half diameter of the wheel. It is unnecessary to make any remarks on the continuation of the description of "Graham's dead beat," with regard to Berthoud's rule, after the notice that has been taken of Berthoud's account of the dead escapement at the beginning of this paper. In the representation of Graham's Escapement, in Rees, Plate XXXII. Fig. 4, before mentioned, the center of the pallets is placed at one diameter of the wheel from the center of the wheel, and the pallets take over eleven teeth. In the representation of the anchor escapement, Fig. 3, the pallets take over ten teeth, and their center of motion is less than one diameter of the wheel from the center of the wheel.

It may be considered requisite, in reference to the subject, that some notice should be taken of the escapement under the denomination of "Modification of the dead beat, by Grinion," described immediately after Graham's dead beat. I shall content myself with observing that Mr. Grinion describes his dead escapement as constructed on the same principle as I. A. Lepautre states Graham to have made his, (see page 10, and Fig. 2, Plate II.,) with the rests of the pallets at equal distance from their center of motion, and with the center of the pallets placed at the distance of one diameter of the scape wheel from the center of the wheel. In the figure (see Fig. 5, Plate XXXII., Rees' plates,) the pallets are represented with the angle of lead of both pallets entirely within the periphery of the circle of the wheel; with the pallets so constructed, the point of the tooth of the wheel would drop on the rest of the pallets at a very considerable distance from the inclined plane, and, consequently, the friction be very much increased; and, moreover, the pendulum must vibrate a very long arc, to enable the pallets to escape at all.

"Bennet's dead beat," represented Fig. 7, is also in the same

case with the angle of lead of both the pallets, entirely within the periphery of the circle of the wheel.

I apprehend a very general and correct rule, and one easy of application, for determining the distance at which the center of action of the pallets ought to be placed from the center of the scape wheel, and for drawing the lines of the dead escapement, may be given.

Having determined the diameter of the wheel, the number of its teeth, and the number of the teeth of the wheel the pallets are to take over, draw a circle circumscribing the points of the teeth of the wheel, and upon this circle at the proper places as determined by the opening of the pallets, mark the thickness of the pallets, which, making no allowance for drops, should always be half the space between two points of the teeth for each pallet; that done, draw two straight lines between the points that mark the thickness of the pallets upon the circumscribing circle; these lines will be chords to the portions of the circle they subtend; prolong these two lines until they intersect each other; the point where they meet will be the proper center of motion for the pallets. Next, to describe the circular faces of the pallets; from the center of motion as above determined, draw portions of two circles that shall intersect the circle circumscribing the wheel at the four points which mark the place and thickness of the pallets. The angle of lead which is quite optional must then be determined—this is done by drawing two lines from the center of action of the pallets; the one within and the other without the lines by which the said center was found, and forming with those lines two equal angles: the angle of lead determined, it now only remains to draw the inclined planes or acting faces of the pallets; this is done by drawing two diagonal lines from the upper to the lower points of intersection of the lines forming the sides of the two angles of lead, by the circular faces of the pallets.

To illustrate this further, suppose ABC, Fig. 1, Plate III, a scape wheel of six teeth, to which it is required to apply a pair of dead-beat pallets, which are to take over two teeth, or what is the same thing, occupy the portion of the circle contained between

three teeth*; circumscribe the points of the teeth of the wheel by a supposed circle Y E Z, divide each of the spaces D E and E F between the teeth D E and F into two equal parts at G and H, draw the straight lines D G and F H and prolong them until they meet at I; the point I will be the proper center of motion for the pallets; from the center I draw the two portions of circles K L and M N, intersecting the circumscribing circle at the points D G and H F, the circular rests of the pallets will be a portion of these circles; the inner rest of the smaller, the outer rest of the larger circle. To determine the angle of lead of the pallets, prolong the two lines I H F and I G D to O and P, and from the point I draw the two straight lines I Q and I R, forming the two angles O I Q and R I P equal to one another, and, from the points F and S of intersection of the sides of the angles by the portions of circles K L and M N, in the one angle, and the points D and T in the other; draw the straight lines F S and D T these will be the inclined planes or faces of the pallets.

As this mode of proceeding would be very difficult, not to say impossible in practice, except in the case of large wheels, on account of the little distance, the points that determine the thickness of each pallet are from each other; the preferable mode is, after having determined the place of the pallets upon the circumference of the wheel as above described, to draw from the center X of the wheel, Fig. 1, Plate III, the two lines X U and X V, bisecting the arcs F H and D G which mark the thickness of the pallets; and from the points V and V where those lines intersect the circle, to raise the two perpendiculars V W and V W, which lines will be tangents to the circle; and that done to draw the lines F H I and

* It may be worth while to notice, as a general rule, that a pair of pallets always occupy the space or portion of the circle contained between the number of the teeth they take over and one more, thus taking over two teeth they require the space contained between three teeth; were they to take over ten teeth, they would occupy the space contained between eleven. The reason is evident; in the one case the thickness of the pallets is without the teeth and the other within, and the thickness of each pallet being equal to half a space, the thickness of the two together must be equal to one entire space; no allowance, as before observed, being made for dross.

D G I parallel to the two lines V W and V W, and the point I where they meet will be the center of motion of the pallets, and must be the same originally formed; for a chord will always be parallel to a tangent touching the same circle, when the tangent touches the circle at a point equidistant between the two points where the chord meets the circle; and that is the case here, for, by the construction of the figure, the angle X V W is a right angle, and the angles V X F and V X H equal angles. The chord H F being parallel to the tangent V W, it follows that the line O I, which is the chord H F, prolonged, must be parallel to the same tangent V W. A similar demonstration will apply to the chord D G.

That there is but one proper place for the center of motion of the pallets, and that it is the point found as above described, will be evident when it is considered, that for the pendulum to be led an equal quantity by the action of the wheel on each pallet, (the inclined planes of which must be of equal length, otherwise the action will not be the same on both,) it is requisite, making no allowance for drop, that at the instant the wheel has advanced a quantity equal to half the space between two of its teeth, the lead of the pallet should be completed, and that the tooth which has just led the pallet to the extremity of the angle of lead of the pallet, should quit the pallet; and, at the same instant, the other pallet should present itself in such a situation, that another tooth of the wheel may come into action with it; that when that tooth shall have advanced the same quantity as the preceding, that it shall also have led the other pallet which it has acted upon to the extremity of its action of lead; and have brought the first-mentioned pallet into a situation to receive the following tooth of the wheel to that by which it was previously led.

This can only be the case when the lines I O and I P which pass through the circumscribing circle, intersect it at the points which determine the thickness of the pallets, which, from the construction, it is evident in this case they do. By reference to the figure it will be seen, that in consequence of the angles O I Q and P I R being equal to one another, and the sides I O and I P of the same angles intersecting the circumference of the circle at the points H F and

G D, (equidistant each to each from the point I), where the circles forming the circular rests intersect the circle circumscribing the points of the teeth of the wheel, the pendulum is led a quantity equal to each of those angles at each vibration. For, supposing the wheel advancing, at the moment the tooth 2 has reached the extremity of the inclined plane of the pallet A A, the point S of the pallet will have reached the point H, and the point T of the pallet B B will have reached the point G, ready to receive the tooth 1, which at that instant will drop upon it; and when, by the action of the tooth 1 upon the pallet BB, it is returned to its former place, the point F of the pallet AA will be ready to receive the tooth 3, which will at that instant drop upon it.

To render the above demonstration as apparent as possible, the wheel has been drawn with only six teeth, because, supposing a wheel even of the size of the wheel in the figure, with thirty teeth, (the number for a second pendulum), in which case the pallet would be only one-fifth of their present thickness, the portion of the circle the chord would subtend would be so short, and consequently the space between the chord prolonged and the tangent so small, that the distance between the points I and W would be much less apparent. In the case of a scape wheel of the size usually employed in seconds pendulum clocks, in laying down the lines for the purpose of determining the distance between the two centers, it will be sufficient, unless when very great accuracy is required, to draw two lines, bisecting the points which mark the thickness of the pallets upon the circle of the wheel, and upon those lines at the points where they intersect the circle of the wheel, to raise two perpendiculars and to take the point where these perpendiculars meet, as the center of motion of the pallets.

Were the center of motion of the pallets placed higher or lower than the proper place, as above determined; See Fig. 2 and 3, Plate III, in both which the angle of lead is drawn the same as in Fig. 1. In the one case, the action of the tooth of the wheel upon the inclined plane of the pallet AA, See Fig. 2, (here the center of motion of the pallets is raised), would lead the pendulum an angle less than the angle of lead O I Q, as drawn, by a quantity equal to

the angle O I X, and consequently the point T of the line T D, or inclined plane of the pallet BB, instead of having advanced a sufficient quantity to meet the tooth 1 at the point G, will only have advanced to H, and the point of the tooth 1 would drop upon the inclined plane H K of the pallet between H and P, and the pallet advancing with less rapidity than the wheel they will meet nearer P than H *.

In the other case (the center of motion of the pallets is dropped nearer to the center of the wheel) the action of the wheel upon the inclined plane of the pallet AA, Fig. 3, Plate III, would lead the pendulum, an angle exceeding the angle O I Q of lead already drawn, by a quantity equal to the angle I O X, and consequently the pallet BB will be led so much too deep into the wheel, that the point of the tooth 1 instead of dropping safely upon the pallet, will drop upon its circular rest at a very considerable distance from the point H †.

It would be impossible for any clock to go with the pallets shaped, as drawn Fig. 2 and 3, Plate III; but it does not follow that pallets could not be made, preserving the same centers of motion, which would perform; and, at first sight, and upon a small scale, appear as mathematically correct as the escapement drawn Fig. 1, Plate III. Such pallets are represented Fig. 2 and 3, Plate IV, applied to similar wheels; taking over the same number of teeth, and acting on the same centers as in Fig. 2 and 3, Plate III. These pallets will be led an equal angle by the action of the wheel on each pallet, and lead the pendulum an angle equal to the angle it is led with the center of action of the pallets in its proper place, as in Fig. 1, Plate III.

* The effect that would result in practice from the tooth dropping on the inclined plane of the pallet, would be to cause the scape wheel, and consequently the whole train of wheels, to recoil; an evil subversive of the principle of the escapement.

† The effect produced by the tooth taking more hold on the circular rest than is absolutely necessary for safety, is to considerably increase the friction on the rest. In practice the tooth should drop just on the circular rest, and no more.

This effect is produced in Fig. 2, Plate IV, by increasing the angle of lead of the pallet AA, and diminishing that of the pallet B B; and it will be observed, that though the two angles B I C, and D I E, the angles the pallets are led, are equal to one another, and, consequently, that the pendulum will be led an equal angle by the action of the wheel on each pallet; yet, that the angle A I C of lead as drawn of the pallet AA, is greater than the angle B I C the pendulum is led, by the angle A I B, representing the difference between the two: and the angle D I F of lead as drawn of the pallet B B, is less than the angle D I E the pendulum is led, by the angle F I E the difference between the two. Consequently, the total difference between the angles of lead as drawn, is an angle equal to the two angles A I B and F I E.

A similar remark applies to Fig. 3, with this difference, that the same effects take place on the reverse pallets; the angle of lead of the pallet AA is diminished, and that of the pallet B B increased: the angles B I C and D I E, the pallets are led by the wheel as in the former case are equal to one another; but the angle A I C of lead of the pallet AA, is less than the angle B I C the pendulum is led, by the angle A I B: and the angle D I F of lead of the pallet B B, is greater than the angle D I E the pendulum is led, by the angle F I E; and the difference between the two angles of lead as drawn, is an angle equal to the two angles A I B and F I E. This alteration of the shape of the pallets, requires a corresponding alteration in the shape of the teeth of the wheel, which must be longer and more undercut, and, consequently, weaker than when the center of motion is determined as shewn by Fig. 1, Plate III*.

* In the case of the center being placed as in Fig. 2, and 3. Plate IV. and the angle of lead of the pallets supposed to be originally drawn as represented Fig. 1. Plate III., the escapement will yet perform, and the pallets lead an equal angle to one another, by the action of the wheel on each pallet, by only altering the angle of lead of one of the pallets, as originally drawn. This is shewn Fig. 1. Plate IV., where the center of the wheel and pallets are placed, and all the parts, the angles of lead of the pallets excepted, are drawn as in Fig. 2. Plate IV.; the angle of lead of the pallet AA is drawn the same as in Fig. 1. Plate III.; but the angle of lead of the pallet B B is dimi-

It now remains to point out the difference between the pallets as drawn Fig. 1, Plate III, and Fig. 2 and 3, Plate IV. In Fig. 1, Plate III, the angle of lead of the pallets as drawn, and the angles they are led are one and the same, and equal to one another; and, consequently, the pendulum is led an angle equal to either of these angles by the action of the wheel on each pallet. In Fig. 2 and 3, Plate IV, this is not the case, it is true the pendulum is led an equal angle by the action of the wheel upon each pallet, the angles B I C and D I E, Fig. 2 and 3, Pl. IV, being in each figure equal to each other, but the angles A I C and D I F of lead of the pallets, are of necessity to enable the escapement to perform, drawn different from each other, and different from the angle the pendulum is led; the one being greater and the other less than that angle. The consequence of this is that the length of the inclined planes of the pallets is also very different, the one being much longer than the other, which renders the fraction upon the two unequal, and probably in the same ratio as the difference in their lengths, and, consequently, the impulse received by the pallets must, from that cause, independent of any other, be unequal. That this is an evil of the first magnitude in the dead escapement, it would be a waste of time to demonstrate; it is only sufficient to observe, that the

nished to an angle sufficiently small to be led by the wheel an angle equal to the angle the pallet AA is led with its angle drawn similar to Fig. 1. Plate III., and the two centers placed as in Fig. 2. Plate IV.

In this figure, see Fig. 1. Plate IV., the angles the pallets are led, and consequently the pendulum, though equal to one another, are less than in Figs. 2 and 3, same Plate, where they are purposely made to lead angles equal to the angle led Fig. 1. Plate III., at the same time they are led angles equal to one another.

If, instead of the angle of lead of the pallet A A, Fig. 1, Plate IV. being drawn as in Fig. 1. Plate III., the angle of lead of the pallet B B had been so drawn, the angle of the pallet A A might equally be altered to suit the action of the pallet B B, and similar effects would result as to the difference between the angles of lead of the pallets as drawn, and the angles led by the action of the wheel on the pallets: and consequently the angle the pendulum would be led, would be considerably greater than in Fig. 1. Plate III. instead of less, as in Fig. 1, Plate IV.

impulses received by the pallets being unequal, the lengths of the arcs of vibration of the pendulum will be unequal, and, consequently, performed in unequal times*.

The angles A I B, and F I E, Fig. 2 and 3, Plate IV, in each figure, being equal to each other, it will be found in all cases, that the excess of the angle led by one pallet, above the angle of lead of the same pallet as drawn; will be equal to the excess of the angle of lead, over and above the angle led by the other pallet.

Supposing the distance between the centers of action of the pallets and the scape-wheel, determined as above described, see Fig. 1, Plate III, and lines drawn from the points where the teeth of the wheel act upon the rests of the pallets, to the centers of motion of the wheel and the pallets, they will form the one an obtuse, and the other an acute angle; and both angles will differ an equal quantity, half the thickness of the pallet from a right angle. Now, in principle, the most advantageous point of action for the wheel upon the rests of the pallets, is at right angles to the two centers of motion; but as it is impossible that the points of action on the two rests should form right angles with the centers, (for were the one a right angle, the other would be the thickness of a pallet greater or less than a right angle,) it follows, that the best construction is, that in which the action of the teeth of the wheel on both rests differs the least possible quantity from a right angle, and is that which will have the least tendency to wear: and as observed by M. Berthoud, No. 1325, "the most favourable possible."

* This is correctly true in the case of the pendulum being supposed a beam, and vibrating a short angle; or in the case of a pendulum with a very light bob suspended on a knife edge, as many of the old clocks were made; but in practice, in the case of a seconds' pendulum, and, still more, a two seconds' pendulum, and a heavy bob, the power of gravity will very nearly overcome the difference in the impulse; nevertheless the inequality of the impulse must, in a certain degree, be prejudicial, particularly when very accurate performance is required.

In the case of the anchor escapement, as applied to watches, the evil would probably be greater and more felt, and cause the arcs of vibration of the balance to be very unequal.

There is a construction of the dead escapement, in which the point of action of the wheel upon the rests may be at right angles to the centers on both pallets, and consequently the rests at equal distances from the center of motion of the pallets; but in that case the impulse upon the two pallets is not at an equal distance from their center, but the thickness of a pallet further from the center upon one pallet, than upon the other. See Fig. 2, Plate II. The impulse upon the inclined planes of the pallets being at an unequal distance from their center, is a most serious defect, and the cause that this construction of pallets is no longer employed *.

Another advantage resulting from the mode of placing the center of action of the pallets as above proposed, is that the wheel will require to be undercut the least possible quantity; for if the center of action of the pallet is raised above its proper center of motion, it will cause the wheel to be more undercut than it need otherwise have been, to free the pallet upon the inner rest on which the wheel acts, otherwise the point of intersection of the inclined plane, and rest of the pallet will cause the wheel to recoil, by coming into contact with the face of the tooth of the wheel: and if the center of the pallets is brought lower than the proper center of motion, it will cause the wheel to be more undercut to free the pallet upon the outer rest on which the wheel acts, otherwise the action of that rest will occasion the wheel to recoil, (though the effect is very much less considerable in this case than in the former,) consequently, the proper centre of motion of the pallets is the most advantageous to the shape of the teeth of the wheel: for, as has been before noticed, the less the teeth of the wheel are undercut, the shorter, and consequently the stronger, they will be. It may be further observed, supposing the center of the pallets to be in its proper place, that the greater the number of the

* It has been before noticed that I. A. Le Pautre, in his *Traité d'Horlogerie*, 4to. Paris, 1767, page 188, mentions, that Mr. Graham made his dead escapement for clocks with the rests at equal distance from the center of motion of the pallets, and has so represented them in the plates to his work.

I do not recollect ever having seen a clock of Mr. Graham's with the pallet made in this manner, though I have seen such applied in old clocks.

teeth of the wheel the pallets take over, the less the teeth of the wheel require to be undercut. It must not be concluded from this, that the number of teeth the pallets take over can be too great, for I believe the contrary to be the case, inasmuch as it is more advantageous in practice to communicate the impulse to the pallets at a moderate distance from their center of motion, which will be the case when they take over six, seven, or eight teeth; than at a very considerable distance, as in the case when they take over eleven, twelve, or thirteen teeth.

To conclude, the great advantage of the mode of determining the distance between the centers of the wheel and pallets, and laying down the lines of the escapement as above described; consists not only in enabling the escapement to be made with the least possible drop, and consequently with the least loss of power, and with the action of the wheel and the friction upon each pallet as equal as it can be in the dead escapement made according to the usual construction with the wheel between the pallets; but on its being of general application, and equally correct whatever may be the size of the wheel, the number of its teeth, or the number of teeth the pallets are made to take over.

In the above, the drop of the escapement has only been mentioned incidentally, and no allowance made for that part of the action of the escapement, which by clockmakers is termed the drop, or beat. In the dead escapement, in common with all other escapements, the drop is an unavoidable evil; and it is sufficient to observe, that the more correctly in principle, and accurately in execution, the escapement is made, the less will be the quantity of drop requisite, and consequently the less the quantity of power lost.

The following observations have arisen out of the preceding pages, and although not immediately relating to the subject of this paper, are, from the relation they bear to the construction of the dead escapement, here inserted:

It has before been observed, (see note, page 3, and Fig. 4, Plate II.,) that the quantity of the angle of lead of the escapement depends upon two things; the angle of the inclined planes,

and the number of teeth of the wheel the pallets take over; and that the escapement may be constructed to lead the pendulum an equal quantity, with the pallets made to take over a few teeth, and with a low angle of lead; or with the pallets made to take over a greater number of teeth, and with a high angle of lead. It may further be noticed, that the lower the angle of the inclined planes, the less will be the friction upon them, and consequently the easier the action of the wheel upon the pallets: because the lower the angle the shorter the inclined planes: and, on the contrary, the higher the angle and the longer the inclined planes, the greater the friction, and the more unfavourable the action of the wheel on the pallets. At the same time it is to be observed, that the less the friction on the inclined planes, the greater the friction on the rests. Supposing the case of two dead escapements, similar in every respect except the angle of lead, of which the pendulums are made to vibrate equal angles, (here the angle of vibration must not be confounded with the angle of lead,) and the pallets of the one constructed with a low angle of lead taking over a few teeth, and the pallets of the other with a high angle and taking over a greater number of teeth; there will in the first case be less friction on the inclined planes and more on the rests, and in the second more friction on the inclined planes and less on the rests; and consequently, in the case of the pallets with a low angle of lead, of the total space of time which is occupied by each vibration of the pendulum, a less portion will be engaged during the advance of the wheel and the giving the impulse, than during the action of the wheel on the rests of the pallets; whereas, in the case of the pallets made with a high angle of lead, the direct contrary will occur; unless, indeed, which is a possible case, the angle of lead should lead the pendulum exactly half the angle of vibration, when the portion of time the wheel is engaged on the inclined planes will be equal to that it is engaged on the rests of the pallets. This observation is made on the supposition that the whole vibration of the pendulum is made with equal velocity, which is not the case; but as the pendulum is acted upon by the clock through the inclined planes of the pallets, both

during its ascent and descent, in the arc of vibration, I do not apprehend the distinction to be very material. Now as all irregularities resulting from the train of wheels, must be more felt during the period the impulse is being given, than during the period of rest, it follows that on that account a low (or short) angle of lead is much preferable to a high one.

It is also worthy of notice, that in the case supposed above, of two pendulums made to vibrate equal angles, by the action of dead escapements similar, except in the quantity of the angle of lead; the pendulum applied to the pallets with the high angle, will be much more liable to come to rest than the other, on account of the excess of the angle of vibration, over and above the angle of lead being less than in the case of the pallets with a low angle of lead.

In a former paper, (see Vol. xiv. p. 334,) I described a new mode of constructing the pallets and their parts, by which great accuracy in the execution of the escapement is obtained. It might appear requisite that I should, to complete the description of the dead escapement, describe the method of dividing and cutting the teeth of the 'scape wheel. But the subject of dividing and cutting wheels has been so fully entered into, and so much has been written on the subject, and much to the purpose, by various authors, who have written on clocks and watches, that it is quite superfluous to add any thing further on the subject.

Art. II. *Account of the Remains of a Roman Camp at Mitchley, near Birmingham.* By John Finch, Esq.

[In a Letter to the Editor.]

Sir, *Birmingham, Sept.* 24, 1822.

Mitchley Camp is situated three miles south-west of Birmingham, near the village of Harborne, and is the property of the Right Hon. Lord Calthorpe. It is noticed by Mr. Hutton, in his valuable history of this town. The exterior vallum is 330 yards long, and 228 wide (by a measurement made as accurately as the ground

would admit,) and enclosing about 15¼ acres. The interior camp is 187 yards long by 165 wide, enclosing 6¼ acres. It is quadrangular, and pieces of ancient armour have been frequently ploughed up.

The ancient vallum and fosse have suffered much by the lapse of time, by the attempts of the occupiers of the farm to level the ground, and by the unfortunate circumstance of the Worcester and Birmingham Canal passing through it, to make the banks of which the southern extremity of the camp has been completely destroyed. Notwithstanding these various means of destruction, sufficient remains are still visible, by which to ascertain that the original camp must have nearly approached the plan which accompanies this. Mr. Hutton describes a third embankment, enclosing thirty acres, and surrounding the two before mentioned, but I could not exactly ascertain it; on the eastern side, there is some appearance of it, but I am uncertain whether it is not the natural formation of the ground. On the north-west, there are decidedly three banks, as the ground being more on a level, required an extra fortification, and I believe the entrance was on this side. At the eastern angle is a field, still called the Camp Leasow, where the ancient entrenchments are very distinct.

Mr. Hutton considers this camp as the work of the Danes, but for the following reasons, I think it may be considered as a Roman station.

"An undertaking of such immense labour could not have been designed for temporary use."

In shape it exactly resembles those camps, which are usually considered as Roman. Those of the Danes were of the most irregular dimensions, and generally placed upon the top of an eminence. This camp is placed upon the side of a hill, and is supplied with water, which is well known to have been considered of great importance by the former people.

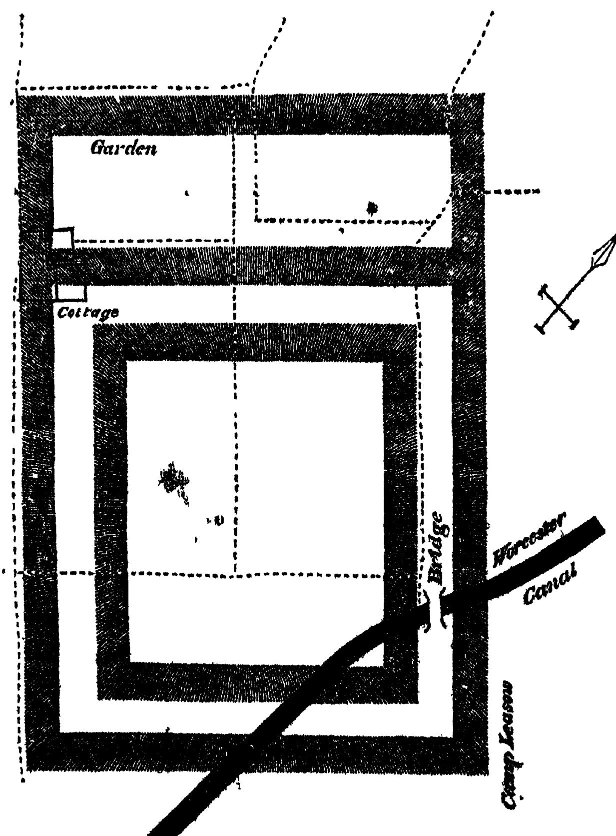
The Ikenield Street runs within a very short distance of this camp. From Etocetum or Wall, to Mitchley, is 16 English, or about 21 Roman, miles; from Mitchley to Alauna or Alcester, is 15 and a half English, or about 20 and a half Roman, miles.

Thus it is situated nearly in the centre between Etocetum and Alauna; and this circumstance, together with the regularity and great strength of the fortification, seem to prove, that it was the intermediate station between them.

I have the honour to be, Sir,

Your most obedient humble Servant,

JOHN FINCH.



Art. III. *Observations on the Project of taking down and rebuilding London Bridge, and on the Design for the New Bridge by the late* Mr. Rennie. *By a* Correspondent.

[Continued from Art. VI., p. 267, Vol. XV.]

It has at length been determined by an Act * of the Legislature, that the hydrometer, by which the individuals possessing property on each side of the Thames between London Bridge and Teddington, have during many centuries regulated the height and strength of their respective wharfs and shores, is to be removed; and the waters of this great river are to be let loose again by the demolition of the dam of London Bridge, not to sap and overflow wastes and desert lands, but fields, gardens, and towns thronged with human beings. What will be the depth of the channel these waters, ungovernable from their increased power, will hereafter scoop out, and what they will carry with them? What will be the declination, speed, and windings of their course, and height at extraordinary high tides? What the deceases from the damps, aqueous vegetation and insects, which will arise from a frequent saturation of the low lands with water? What will be the spread of pestilent filth from the sewers of London on this river's flat banks, at the ebbing of the tide?—are questions to which no answers have been ventured. The warnings of common sense, in respect of the soil, site, and plan of the Penitentiary, now lingering with its inmates, were contemned a few years ago; as those are at the present time in respect of the destruction of property and human life, consequent on this intended revolution of the ancient government of the Thames †.

Engrossed in the consideration of this adventurous speculation, the writer of these observations took little interest in the contentions relating to the designs for the new London Bridge, nor con-

* 4th Geo. IV., Sess. 1823.

† See Art. VI, in the July *Journal*, and Mr Telford's Report in the *Phil. Mag.*, published the last day of July *ult.*

templated the grandeur of the work about to be erected. But having received from a friend the Act "for the rebuilding of London Bridge," and a drawing of the new bridge designed by the late Mr. Rennie, his attention has been more particularly drawn to it; and the examination makes him regret that he cannot be convinced of the expediency of a new bridge; for, to see across the Thames an elliptical arch in stone, whose transverse axis is 150 feet, and its semiconjugate 29 feet 6 inches, with two other arches on each side of it, of a like character, standing on bearing piers 45 feet high, would afford him a gratification which he is unable to express. In such a work it seems proper that the most able person should be selected to furnish the design, and erect the bridge; and doubtless the late Mr. Rennie was that person. It also seems proper, now that gentleman is no more, that the faith he would have inspired, should be obtained by investigation and proof. In the absence of any shewing of the expediency of the demolition of London Bridge, and of the reality of any beneficial effects to arise, or of the fallacy of the evil effects anticipated from it, and in the want of every scientific explanation of the principles by which the late Mr. Rennie regulated the proportions of his bridges; the observations in respect of the taking down the present bridge, and the following inquiry in respect of the new one, are submitted to you, not without a hope that in your next Journal all the desiderata will be supplied by some one of those who have pledged themselves to the success of these undertakings.

When the heights of the piers, and form of an arch of a bridge, and the kind of stone of which it is to be constructed, are determined, the first object of inquiry is the thickness of the arch at the vertex. Mr. Rennie, in his stone bridges, adopted the rule* which M. Perronet† says is customary in large arches surbaissées, namely, to make the thickness at the vertex of an arch

* Examples—Waterloo, Darleston, and Weston. The key-stone in the faces of Waterloo is said to be only 4 feet 6 inches, but the thickness of the arch is 5 feet $= \frac{120}{24}$.

† *Œuvres de Perronet*, pages 625 and 664.

$\frac{1}{24}$th part of the span; we may therefore conclude, that the thickness of the arch of the new London Bridge there was intended to be $\frac{150}{24} = 6$ feet 3 inches; and this conclusion is confirmed by the other parts of this bridge, and so far as the scale of the drawing of it is evidence. This rule is purely empirical, and so acknowledged to be: it may apply for Neuilli bridge with Saillancourt stone, but it does not apply with marble for the bridge of the Holy Trinity * at Florence, and ought not with granite at Waterloo bridge, nor cannot apply in arches surbaissées in all their varieties. The versed sine of the bridge of the Holy Trinity is between $\frac{1}{8}$th and $\frac{1}{7}$th of its span, and its thickness at the vertex is $\frac{1}{40}$th part of the span. The rule also, which Perronet gives in another part of his work, in order to evade an obvious absurdity, *viz.*, that the thickness at the vertex of an arch should be $\frac{1}{24}$th of double the radius of curvature there, leads to greater absurdities than that of which the latter is an evasion. For, in the case of the bridge of the Holy Trinity at Florence, the thickness of the arch at the vertex is the $\frac{1}{192}$nd part of the diameter of the circle of curvature there, and that of his own bridge of Neuilli is $\frac{1}{100}$th part. It is desirable that a mode of determining this important feature of an arch could be obtained directly from the strength of the material to be used, and the weight to be borne, making due allowances for contingencies; and also, when this is derived, to determine any point of thrust, and the correspondent angle, that is, the extrados of an arch, and its abutment or bearing piers, from the same sources. These questions M. de Prony, in the first volume of his *Nouvelle Hydraulique* †, investigated; but assuming the angle of rupture with the vertical gratuitously, and not having illustrated by examples the application of his formulæ, the articles require more *eclaircissement* than M. Garnier has given them in the Introduction to the second volume, before they can be available to the practical professor. The solution of these questions has also been given analytically

* No. 29, *Journal of Science*, Roy. Inst., for April *ult.*

† Art. 358 to 379.

in a work * published in the commencement of 1822; the latter had been geometrically solved by the same author about fourteen years ago. His formulæ may be applied to the case of the proposed new London Bridge, as follows:

Let the material be Cornish granite; then it may be deduced from the experiments of Mr. George Rennie, in the *Phil. Trans.* 1818, that a prism of this material will crush at its base, if it be 5500 feet high. Let a prism one foot square in horizontal section, one-fourth of that height †, be denoted by $f =$ 1375 ‡ Feet

Let the height of another prism of the same section, and of the same material, equal in weight to the weight to be borne, allowing for contingencies, be denoted by . . . . $w =$ 24 §

One cubic foot of the same material, by . . $g =$ 1

The thickness of the given arch at the vertex, by $n =$ 6,25 ||

The breadth of the given arch, from face to face, by $b =$ 50 ¶

The semi-transverse, by . . . . . . $t =$ 75

The semi-conjugate, by . . . . . . $c =$ 29,5

The radius of curvature of the arch at the vertex, by $r =$ 190

$$\frac{(2t)^2}{4c} = \frac{22500}{118} = 190$$

* *Tracts on Vaults and Bridges*, pages 36 and 67, Tract 2.

† Mr. Emmerson considered that one-fourth of the breaking strength should be considered the practical strength, which rule seems to have been adopted by the late Mr. Rennie, according to his evidence before Committees of the House of Commons.

‡ The weight necessary to crush a thin piece of Cornish granite $1\frac{1}{2}$ inch square, is 14302 lbs. avoirdupois. A foot cube of Cornish granite weighs 2662 ounces avoir. = 165,4 lbs. and $\frac{14302}{165,4} \times 64 = 5500$ and $\frac{5500}{4} = 1375$.

§ M. Perronet considered that 14 times the probable weight should be added for insurance weight, taking 4000 lbs. = the possible pressure and concussion per foot sup.; then $\frac{4000 \times 16}{2662} = 24$.

|| $\frac{150}{24} = 6,25$, being $\frac{1}{24}$th of the span.

¶ Mr. Mylne recommended the bridge should be, when rebuilt, 50 feet. The engraving does not show the intended width of Mr. Rennie's design.

	Feet.
The height from the bottom of the grating to the vertex of the extrados of the arch, by . . .	$m = 80{,}75$
$45 + 29{,}5 + 6{,}25 = 80{,}75$.	
The distance of the extreme point of thrust at the level of the bottom of the grating, from the middle of the arch, by	$d =$
The angle of thrust at the extreme point, with a horizontal line at the level of the bottom of the grating, by	φ

In respect of the thickness at the vertex of an arch equally stable in all its parts; it is shewn in the work referred to*, that the compression at the vertex is equal to the weight there multiplied, by the radius of curvature there, and also equal to the horizontal thrust, and thence the force of horizontal thrust $= (ng + w)\ br$, and since the area of the vertical section $= nb$ square feet, and the repulsive strength of the material $= f$ in linear feet; it follows that nbf must represent the force to crush the thickness at the vertex. Whence $nbf = (ng + w)\ br$ from which is obtained $n = \dfrac{w}{\dfrac{f}{r} - 1} = \dfrac{24}{\dfrac{1375}{190} - 1} = 3$ feet 10 inches, supposing the arch at the vertex uniformly thick, that is, without ribs.

The formulæ given to determine the point and angle of thrust at any level from the vertex to the foundation, extracted from that work, and applied in this case, are as follow:

$d = \left(\dfrac{2cn}{t} + \dfrac{t}{v}\right)\sqrt{v^2 - 1}$ in which v is to be obtained from the formulæ $v^3 - \left\{1 + \dfrac{t^2(m - c)}{c^2 n}\right\} v = \dfrac{t^2}{cn}$ an equation of the form $v^3 - pv = h$ falling under the irreducible case wherein $\left(\dfrac{p}{3}\right)^3$ is greater than $\left(\dfrac{h}{2}\right)^2$. Therefore by the known formulæ $\dfrac{3h}{2p}\sqrt{\dfrac{3}{p}} = \cos. z$ and $v = \dfrac{2p}{3}\sqrt{\dfrac{3}{p}}.\cos.\dfrac{z}{3}$ and

* *Tracts on Vaults and Bridges*, pages 37 and 67, Tract 2.

table of natural sines and tangents, v may be obtained *. Tang. $\varphi = \frac{c}{t}\sqrt{v^2 - 1}$.

When $n = 6$ feet 3 inches, d becomes 111 feet 6 inches, and $\varphi = 71^\circ 23'$. When $n = 3$ feet 10 inches, d becomes 103 feet 6 inches, and $\varphi = 75^\circ 7'$.

Whence in the first case the width of the grating at the level of the foundation is 51 feet, exceeding by 8 feet, the width of the grating in the drawing, but the width of the piers, at the level where the line of water is shewn, and they rise vertically, becomes 22 feet, very nearly conformable to the dimensions of the drawing taken from the scale; and in the second case, the width of the grating at that level becomes 41 feet, and the pier at the level of the water 16 feet.

The 51 feet, and the 41 feet, give the extreme points of strutting; but the first would be strutted to a balance, if the grating were 28 feet wide, and the second 26 feet, which dimensions, in the case of bearing piers, would generally be considered safe. In Waterloo Bridge, the bearing piers are sufficiently thick for abutment piers, and the width of the grating in the bearing piers, conforms to what would be obtained from the above formulæ, so that it is probable, in that bridge Mr. Rennie used the geometrical construction before referred to, or one producing the same result.

If the thickness at the vertex be taken at 6 feet 3 inches, and the width of the vertex stone, at the intrados be taken 20 inches; then the summering of that stone will be $\frac{3\frac{1}{2}}{12}$ of an inch, that is, the extrados of that stone will be $\frac{7}{12}$th of an inch wider than the intrados, that stone approaching very near to a parallelopiped. If the thickness be 3 feet 10 inches, then the difference between the extrados and intrados of that stone will be $\frac{4}{10}$th of an inch.

Partly to avoid the hazard of so little summering in the case of a deficiency of strutting in the abutments; the Gothic archi-

* This operation is facilitated by Mr. Barlow's Table IV., *New Math. Tab.* 1814.

tects very wisely abandoned round-headed arches, and adopted pointed arches. Their arches surmounted, were composed of two arcs of a circle, their arches depressed, were composed of two arcs of an ellipse; the latter kind did not prevail until the time of Henry VII. It is manifest, that these arches greatly increase the summering of the vertex stone. Ammanati, at the bridge of the Holy Trinity at Florence, to his great honour, living at the revival of Roman architecture, adopted a pointed arch of Henry the VIIth's time, with that style of architecture.

Having derived that the thickness of the arch at the vertex being of an uniform thickness directly from the strength of the material, and the weight to be borne, this result leads to the consideration of another practice of the Gothic architects, not less wise than that just mentioned, by which the great cost, and the great strain and compression, and consequent variation of the form, of the wooden centring is materially reduced; and the abutments are subjected to less thrust and weight, *viz.*, by using ribs, or what in Roman architecture are called double arches. By this practice, the wooden centring became a mere skeleton, or in the mason's phrase "a horse," on which they constructed another skeleton, or the sub-arches, which they then keyed, and on the stone skeleton as a centring, they then laid the arched ceiling or floor, adopting the same course, as from necessity modern bridge builders do in erecting iron and wooden bridges. The Gothic architects also, in order to save the walling and stuffing in the spandrills, and to bring up the arch to the road, and consequently to reduce weight and expense, sometimes pierced the bearing piers by arches longitudinally, to which the cut-waters became abutments, and took their share of pressure. Perronet imitated this arrangement at the bridge of St. Maxence. Others have pierced the bearing piers transversely, with œils. Perronet gave grace to the elevation of the bridge of Neuilli by splaying the angles of his ellipses to an arc of a circle, by what have obtained the name of Cornes de Vache.

It would be in vain, in the present state of the science and art of bridge building, to urge, the adoption of such of these excellent inventions, as apply in the case, and also to advocate a due

regard to the architecture or dress for the proposed design: the practical professors of bridge building, have generally from their talents emerged from subordinate trades; and their want of knowledge in the details of architecture, and their habits, lead them to what is easy in design and execution; hence their works are marked with the characteristics of a barbarous time. A more advanced age will, probably, in contemplating this work, when spanning the Thames, regret a delay in the revival of the science of Ammanati, and the architecture of Palladio.

The design of the late Mr. Rennie for this bridge seems to have been adapted to a river, where the banks are flat, and of an equal height, and for a canal, in which the current and deep channel, could be maintained in the mid water: how it applies to the site of the present London Bridge may be ascertained by a reference to a section across the river, and through the streets at the site; and by a plan of the river in which its sinuosities are accurately laid down*.

In a question involving the consideration of the effects of altering the habit of such a river as the Thames; of an expenditure of about one million and a half of pounds sterling, simply for that purpose; of the reputation which may be acquired by this country from the science and art displayed in the erection of so magnificent and difficult a work as the proposed new bridge; it will scarcely be thought by any one, that the pages of your Journal can be misapplied in an inquiry into the expediency of taking down the present bridge; into the good effects to be derived from the demolition of the dam, contrasted with the ill effects foreboded from it; and in urging, as a compliment to the real and affected science of the age, that some exposition of the principles upon which the parts of this bridge have been proportioned, and of the results of the experiments made of the strength of the material of which the bridge is to be constructed, should be given for the information of the public, and its use in future on similar occasions.

* It is to be regretted that the plans and sections made by Mr. Telford, in his Survey of the Thames, were not published with his Report.

In the case of the iron arch of 600 feet span, designed by Mr. Telford, for the same site, which was to have cost only 262,289*l.*, it was thought right, that a series of questions should be submitted to the scientific and practical men of the age, accompanied by drawings of that proposed structure, and their answers have been of considerable advantage, in extending a knowledge of the science of bridge building. It would be a great public benefit if the same proceeding were adopted in this case; but the question and data ought to be corrected, if not prepared, by some one who knows both what will be useful to the practical professor, and what will be amusing to the mathematician.

Art. IV. *Remarks on the Deposition of Dew. By* George Harvey, M.G.S., *&c. &c.*

Du Fay mentions an interesting example of the influence of metals in retarding the deposition of dew. He found, that a watch glass resting on a silver plate, and surrounded with a ferrule of the same metal, had a space round its border five or six lines wide, perfectly dry, and towards which the drops regularly decreased in magnitude. In performing the experiment, however, I found, that not only a dry zone surrounded the edge of the glass, but a circular space, equally dry, existed in the middle of its surface, together with two narrow zones of dew, composed of exceedingly fine particles, surrounding the borders of the middle zone, and which last was covered with drops of a larger size.

At the time the experiment was performed, the whole night was devoted to some general inquiries relative to dew; so that ample opportunity was afforded of observing its first deposition, and also the gradual steps by which it successively accumulated.

At sunset, on the 15th of May, two watch glasses, of equal dimensions, were placed, with their concave sides upwards, on a plate of highly polished block tin, one of them being surrounded with a ferrule of the same metal, of the same diameter as the glass, and a depth equal to its versed sine.

It was not until half an hour after sunset, that the temperature

of the glass was sufficiently lowered, to admit the stratum of air in contact with it, to impart a portion of its moisture. The dew first made its appearance on each of the vitreous surfaces, like the effect produced by a gentle breathing. There was a difference, however, in the manner in which the moisture was deposited on the two glasses. In the crystal without the ferrule, it was confined to a zone, bounded on one side by the edge of the glass, and on the other by the circumference of a dry transparent circular space, formed in the middle of the surface, of an inch and quarter diameter; but in the other, the circumference of the dry lucid circle formed the inner boundary of the dewy zone; and a circle distant about a quarter of an inch from the circumference of the glass, formed the outer. At half past nine, the particles on the inner edges of both zones, preserved their minuteness; but in the former glass there was a small but perceptible increase in their magnitude, to its extreme edge; whereas, in the other, the increase proceeded not only from the inner edge, but from the outer, producing thereby the largest particles in the middle of the zone.

At the expiration of an hour, a new appearance was presented. Within the dewy surface of the former crystal, another very narrow zone of moisture was perceptible, composed of exceedingly fine particles. The two zones were not blended together, a distinct line of separation being visible between them. The formation of the latter necessarily diminished the diameter of the lucid circle, since the whole of it appeared to have been formed within the dry space. The surface of the glass, therefore, was divided into three compartments:

1st. The outer zone, composed of particles decreasing from its exterior to its interior boundary.

2d. The narrow zone of very fine particles, its greater circumference being in contact with the inner boundary of the former.

3d. The dry transparent circle.

The surface of the other crystal presented a similar zone of minute particles, on each side of the first mentioned dewy zone; so that its surface was divided into five compartments:

1st. A dry transparent zone.

2d. A narrow zone of exceedingly fine particles, having distinct boundaries.

3d. A zone composed of particles increasing in size from both its boundaries to its middle.

4th. A narrow zone of exceedingly fine particles, having distinct boundaries.

5th. A dry transparent circle.

At midnight, the only perceptible changes were an increase in the magnitudes of the drops of dew, a small diminution in the diameters of the dry circles, and also in the breadth of the dry zone. At two in the morning, the drops in the larger zones had farther increased, and the dry parts still remained without moisture. At four, the moment which marked the greatest depression of temperature, the larger drops had increased considerably; and the finer particles in the narrow zones, had also augmented in size. The breadths of the latter were, however, still preserved, in common with the other zones, and the dry portions of the crystals.

The appearance of the glasses at each period of observation, was extremely interesting. After the particles of dew had increased to a certain size, the glassy surface very much resembled the white metallic paper used in ornamental works. About an hour before sunrise, a small pellucid drop appeared in the centre of the dry circular space, formed from the moisture which had been deposited on the outside of the glass, and which had descended to the lowest part of the crystal. When the glass was raised, the drop remained on the metal. The sudden application of heat to the crystals, was always accompanied by a partial disappearance of the minuter particles of moisture. This was observed, both when the glasses were handled, and when a candle was brought near them, for the purpose of examination:—affording an indirect proof of the theory of Dr. Wells, that the primary cause of dew, and all the interesting and beautiful phenomena arising from its numerous modifications, are to be traced to changes and varieties of temperature.

To the feeble manner in which heat is emitted from highly polished metallic surfaces, and the check which their influence communicates to bodies having considerable radiating powers, and in

contact with them, may be referred the cause of the phenomena above described. The glass, for example, with a very superior propellent energy, had a portion of its surface touching that of the polished tin, which radiates heat but imperfectly. The resistance which this feeble radiation offers to the formation of dew, being communicated to the vitreous surface equally in all directions, but confined to within certain limits, will explain the cause of the absence of moisture in the bottoms of the glasses, and also why their dry portions were of a circular form. The uniform breadth of the dry zone, in the crystal surrounded with the ferrule, may be referred to the same cause.

The gradual increase also of the particles of the dewy zones, from the borders of the lucid portions of the crystals, affords a beautiful proof of the general influence of the metal, and of the gradual steps by which that influence is diminished. In the glass surrounded with the ferrule, the deposition of dew was checked, both by the metal on which it rested, and by the ferrule itself. This double influence necessarily occasioned each border of the zone of moisture, to be formed of the smallest particles, and the middle portion of the same, of the largest; that being the part of the surface where the joint effect of the metals was the least. The other glass, being subject only to one of the influences here alluded to, necessarily had its minutest particles confined to the inner edge of its zone; and, consequently, those of the largest size, on the extreme border of the crystal; that being the part farthest removed from the influence of the tin.

In particular conditions of the atmosphere, and after a metallic surface has been, for some time, exposed to its influence, it will approach very nearly to a state favourable to the formation of dew; or, as sometimes happens, moisture will be deposited on it *. During the night when these experiments were performed, the latter

* The difficulty with which polished metals are dewed has been long known. But there are some circumstances connected with the deposition of dew on their surfaces, at particular elevations above the ground, which merit the further attention of philosophers.

condition did not exist, but a close approximation to it took place. This new state of the metallic surface necessarily restored, in some degree, the diminished radiating power of the glass; and hence produced the narrow zones of fine particles, formed after the first deposition. Nor is it improbable, though I have not met with an experiment to verify it, but that the moment marked by the deposition of dew on a metallic surface, would also be distinguished by the appearance of moisture on the dry portions of the crystal. And from the principle also, that dew is deposited more readily on horizontal, than on vertical, surfaces, we may anticipate that moisture would appear earlier, as well as more copiously, in the dry circular space at the bottom of the glass, surrounded with the ferrule, than in the dry zone round the border of the same crystal.

On the 10th of June the following observations were made on the temperature of glass resting on the green herbage, and that of the air twelve inches above it. The experiment was instituted to observe if the deposition of dew *immediately* succeeded the depression of the temperature of the body on which it was formed, *below* that of the stratum of air hovering over its surface. From the table this appears to have been the case.

Time.	Temperature of glass resting on the herbage.	Temperature of the air twelve inches above the ground.
5¼ P.M.	73°	70°
5¾	70°	69°
6¼	66°	67°
6¾	63°	66°
7¼	61°	65°
7¾	59½°	64½°
8¼	58°	63°
9¼	57°	62°
9¾	56½°	62°
10¼	59°	62½°

The first perceptible trace of moisture was observed on the vitreous surface resting on the grass, at six; and at a quarter of an hour after, it was distinctly visible. At fifteen minutes before six;

the temperature of the glass was 70°, and of the air 69°, when no moisture was perceived; but in the space of half an hour, the former indicated 67°, and the latter 66°, at which moment dew was clearly perceptible; agreeing precisely with the discovery of Dr. Wells, *that bodies become colder than the neighbouring air* BEFORE *they are dewed.*

The sun at six P.M. had an elevation of 17 degrees, but its direct rays did not reach the place of observation. The sky also was tranquil and unclouded. It was not, however, till a quarter after seven, that dew was perceptible on the glass elevated 16 inches above the field, an instance of the slowness with which the cooling power of the land imparts its influence to the neighbouring air. At a quarter before eight, just as the solar orb was disappearing, the temperature of a glassy surface, 30 inches high, was sufficiently low to obtain moisture from the air reposing on it. By sunset, masses of wool, of twelve grains each, placed on the metallic plates resting on the grass, and at the respective heights of 16 and 30 inches, received increments of dew amounting to 4, 3½, and 3 grains. *Dew, therefore, is deposited in shady places, long before sunset.*

In consequence of the interposition of a dense cloud in the zenith, from half past nine to half past ten, the temperature of the grass was elevated two degrees and a half, and that of the air, half a degree, as may be seen by a reference to the table. The effect of a mass of clouds in elevating the temperature of the land, was first observed by Mr. Wilson, of Glasgow, and afterwards confirmed by Dr. Wells. At the present time, however, it was remarked, that the appearance of the cloud was accompanied by an almost entire suspension of dew; and the minute quantity deposited probably owed its origin to the clear horizon. In the interval between a quarter past five, and half past nine, a mass of wool, of 12 grains, received an increment of six grains and a half; but from the last observation, to half past ten, the quantity gained was only half a grain; and its almost total suspension could be attributed to no other cause than the appearance of the cloud; since the air preserved its tranquillity, and every other circumstance, ex-

cepting that of temperature, remained the same. Soon after the last observation, the upper sky again became clear; when the formation of dew was actively resumed, and an additional quantity, amounting to ten grains, deposited by six the next morning.

On the 16th of May, the sun rose about a quarter after four; and from that time to six, dew was deposited on wool and swandown placed on grass, and at the elevations of 5, 18, and 32 inches above the ground. Nor was the quantity, in some cases, inconsiderable, it varying from one to three grains. At the last observation, the sun had attained an elevation of 13 degrees; and for half an hour previous to it, had thrown its direct rays on the scene of the experiments. *Dew, therefore, is deposited after sunrise.*

Plymouth, July 25th, 1823.

Art. V. *On Animals preserved in Amber, with Remarks on the Nature and Origin of that Substance. By* J. Mac Culloch, M.D., F.R.S.

The value which has long been attached to the specimens of amber which contain insects, has introduced into the cabinets of collectors many imaginary examples of this occurrence, which a more careful examination would have proved to be fallacious. For the sake of those who may be inclined to purchase such specimens, or to re-examine their own acquisitions of this nature, it may be useful, not only to suggest the frequent deceptions to which they are exposed by not attending to the real characters of the including material, but to point out an easy method of distinguishing the true from the false. It is the more necessary to do this, as the test which the Abbé Haüy has given, in his work, for this purpose, is neither satisfactory nor of easy application.

The existence of an insect in amber, is an unquestionable proof of the vegetable origin of this remarkable substance, and is, therefore, in a mineralogical view, an important fact; but to find such an animal in the exudation of a living vegetable, is scarcely a subject

of curiosity. It is, in another respect, important to show, that such remains, if most frequently occurring in the recent resinous exudations, are not limited to them; since collectors, finding themselves deceived in their own specimens, might perhaps imagine that no genuine instance of an insect, actually preserved in amber, exists.

For the honour of the dealers in specimens, it is, however, but justice to remark, that the difference is not, or at least not generally, known to them; as, among innumerable specimens exposed for sale which I have examined, I have never yet found any of the proprietors aware of the distinction. False specimens seem, at any rate, to be true in their eyes, as they are in those of the purchasers. A very perfect state of preservation in such insects as may be surrounded by any substance resembling amber, is generally a justifiable ground of suspicion respecting the nature of the including material. It rarely happens that those insects preserved in amber are perfect, or that they present the more delicate part of the anatomy of the animal; the wings of the hymenoptera, for example, or their delicate legs.

It would require too much nicety of observation for an ordinary naturalist, perhaps too much for any one, to decide on the recent nature of the including resin from the characters of the insect contained in it; when it is considered how many insects are yet unknown, and how difficult it is to examine the enclosed specimens accurately. Otherwise, as there is abundant reason, from the analogy of other animal remains buried in alluvial matter, to conclude that insects enclosed in amber have belonged to a former state of the globe, this difficulty might be solved by the entomological examination of the species. To ascertain the true nature of the including material, is a task of great comparative facility; and it is always sufficient for the purposes in view; that is, for ascertaining, simply, whether the specimens consist of amber, or of some recent resin enclosing animal remains.

Where the exudation is sold in its natural state, the form of the lengthened mass, or drop, is generally a sufficient evidence of its real nature; as no amber is ever found which has not undergone

some loss of shape, from mechanical violence, or other causes, connected with its present mineral position.

But it frequently happens that this test becomes of no use; as the specimens are often cut and polished into such forms as to show the enclosed insect to advantage. Even in these cases, however, the colour and appearance of the resinous matter which encloses the insects, are always somewhat different from those of amber; or they are always, at least, such that a practised eye can pronounce on the genuine specimen; can distinguish between resin and amber. A paleness of colour is invariable in the resin; and if amber is not always of a full yellowish brown, the paler varieties have a peculiar tinge of yellow which never exists in the resin; the colour of these is comparatively watery, thin, and feeble.

The striking character, however, to a practised eye, is a peculiar lustre in amber which is wanting in the resin; arising, probably, from a higher refractive density, and easily recognised when once pointed out; but difficult to describe in words.

To those to whom characters of a nature so delicate are insufficient, it is necessary to point out other more unquestionable and easier modes of discriminating the two without injuring the specimens.

It is proper, in the first place, to remark, that the electrical property is not a sufficient test; although it is that to which an appeal is commonly made. The resins, like amber, are electrical on friction, and the electricity of both is negative. But, on strongly rubbing the resins, they give out a smell quite different from that which is elicited from amber in the same circumstances. To describe these odours, is evidently impossible; but as they can never be mistaken for each other when once known, it will be necessary for the collector of specimens to render himself acquainted with both; by making the necessary experiments on genuine specimens of common amber, and on specimens of that resin which, if it is not the substance in question, agrees with it in its ostensible properties, namely, gum animi, as it is commonly called.

It would obviously be easy to supply chemical tests for the

purpose of making this distinction; but the circumstances under which these specimens exist, are not such as to warrant their destruction for this purpose; and, to ordinary collectors, any refined or minute mode of chemical examination would be useless. The only easy test which can be applied without destroying or materially injuring a specimen, is that of burning. If the doubtful specimen be held against a red-hot iron, the smell of the smoke which is produced is always a sufficient distinction between the resins and amber; and, to render this test of easy application, the collector may easily familiarizes himself with the peculiar smells of the essential oils, which, with very slight differences, are given out by copal, gum animi, or the other recent resinous substances, and that of the oil of amber which is produced by burning this mineral.

To this ultimate test, therefore, in doubtful cases, the collector of specimens may have recourse; and it will always be sufficient to distinguish, from genuine specimens of insects enclosed in amber, those which have been entangled in the recent resinous exudation of trees. Hauy's test of the difference between copal and amber, already alluded to, and which is founded on the different manner in which a melted drop falls from each, is neither so practicable nor so satisfactory.

I am sorry that I cannot inform your readers what is the real nature of the vegetable resin in question, which is commonly sold for amber when it contains insects. It has not been a matter of observation among the collectors of these specimens, or the dealers in them. Nor, as far as the chemical analysis of vegetable compounds has yet proceeded, have we acquired any means of ascertaining by chemical means the distinctions among these, more than among any other vegetable products, of which the general and ostensible characters are similar. It is however plain that it is not copal, at least in all cases; but it bears, as already insinuated, a striking resemblance to the gum known by the name of gum animi. That such insects should be contained in more resinous exudations than one is to be expected; and if those who are inclined to pursue this investigation should think it worth their

trouble to make the necessary inquiries and experiments, it will probably not be found very difficult to ascertain whether these specimens are limited to the produce of many trees, or to that of one only, and to what plant they actually belong.

The immediate object of this paper is included in the foregoing remarks; but the fact itself, as far as it relates to the existence of insects in amber, opens a different field of interesting inquiry, respecting which, unfortunately, no accurate information will probably ever be obtained.

Geological observations, recently multiplied to a most interesting degree, have proved, that besides the animals imbedded in deep-seated strata of solid rock, and consisting of marine species, numerous remains exist in alluvial soils, of quadrupeds and birds which have once inhabited the dry land and the air, and of amphibious creatures that have been bred and have died where they have had alternate and easy access to the shores and to the waters of lakes.

It ought to be a sufficient proof of the corresponding, probably simultaneous, existence of insects, that they are found imbedded in amber; the only mode nearly in which they could have been preserved for the examination of the naturalists of future and distant ages, though some of the aquatic, or rather subaquatic, winged ones, have been found in the shales of the fresh-water formations. To render the proof of distance of time, or of a corresponding era complete, it is only here necessary to advert to that which is already well known; namely, that amber is found in alluvial soils of an antiquity at least as remote as that which marks the other alluvial soils or strata in which such remains of a former living inhabited world are imbedded. That this should have been the fact, is too probable to doubt, even if such proofs did not exist. Whether specimens sufficiently numerous, and sufficiently distinct, may ever be found to enable some future Cuvier in entomology to assign the genera and species of such remains, is uncertain; perhaps it is not probable.

Hitherto, it is certain that no sufficient attention has been paid to this branch of subterrene zoology, to the entomology of a former

world. To clear the way to this investigation, by guarding against error in the specimens, is a humble step indeed. Yet to have called the attention of those who are versed in the minutiæ of entomology to such a subject, will not be deemed officious in him who is unable to lend any further assistance towards that object. A careful examination of specimens may, perhaps, ultimately prove that more is really in our power than we now suspect; and it is not quite unreasonable to hope that the entomological sagacity of a Latreille may hereafter perform for fossil entomology that which a few years ago would have appeared equally improbable in the history of extinct quadrupeds.

It is in the fresh-water formations chiefly that these researches ought to be made. A considerable number of the coleoptera inhabit the water or frequent it; and the bodies and wing-cases of these are of such durable materials, that we might expect to find them preserved in those deposits of mud, or sand, or calcareous matter, which afterwards become the sand-stones, shales, and limestones of these deposits. For analogous reasons, we might expect to find insects among the coal strata, since these also are of terrestrial or fresh-water origin, as we might further expect to discover them among the lignites. These are the produce of ancient forests and peat-bogs; and there is no apparent reason why some of the more durable insects might not, as well as the tender shells, be found in such situations. But nothing will be found unless it is sought for.

I have taken it for granted, throughout this paper, that the vegetable origin of amber is admitted; improperly, perhaps, and, for that reason, it will not be irrelevant to add a few words on the nature of the evidence on which this opinion rests.

The existence of such animal remains in any undisputed specimens of amber, ought, in itself, to be a sufficient proof of this origin for the whole. It is impossible to conceive that winged insects could be entangled in any substance of this nature under any other circumstances; while their actual existence in resins now exuding from living vegetables, serves to explain the mode in which this otherwise inexplicable event must have occurred.

The chemical connexion between amber and the existing resins, must also be proved, if that be thought necessary for strengthening this view, by such analogies as can be brought to bear on it, since it is not matter for direct experiment.

In analyzing chemically the vegetable resins which most resemble amber in their general characters, and in comparing these results with those obtained from the analysis of amber, certain important differences are observed. To enter into the whole of these would exceed the bounds I have here prescribed for this paper. It is sufficient to say, that the essential, or volatile, oils, obtained from all the resinous substances, possess a general resemblance to that obtained from common rosin, or, to the oil of turpentine; and that they exhibit the same chemical qualities, as these relate, in particular very conspicuously, to their habitudes with alcohol and ether, and, especially, with naphtha, and to the action which they exert on the solid resins and on the solid bitumens.

The same general powers and properties are found in those essential oils which are produced by the decomposition of recent vegetables and the recombination of some of their elements: and thus a general character is found to pervade all those volatile oils which are the produce of recent vegetable matter under whatever form. But, in analyzing in the same manner, and reproducing volatile oils from vegetable remains, which have been so long and so deeply buried in certain alluvial soils as to lead us to suppose that they have belonged to a pre-existent state of the surface of the earth, it is found that these are essentially different. The volatile oils thus produced, approach, in their chemical affinities towards those which are obtained from coal; or from a substance, of which the vegetable origin is rather generally admitted than demonstrably proved. They are all varieties of naphtha, under modifications which, having fully explained them in other writings, it is not necessary here to detail again.

Now the same analogy holds in comparing the produce of the vegetable resins with that of amber, as occurs in comparing the oil of recent wood with that of jet, and more particularly with that of coal. It is here unnecessary to enter into the minute differences

n these cases. The oil of amber, in all its most important characters, resembles naphtha; and thus it might, *à priori*, be suspected, that the same influence which could render wood in the form of jet (or coal), capable of yielding naphtha, might, under analogous circumstances, so change a vegetable resin as to cause it also to yield a species of naphtha instead of the resinous essential oil. This probability, of the change of vegetable resin into amber by long submersion in alluvial soils, is strengthened by other analogous occurrences.

In the submerged wood (brown coal of Bovey), a substance is found, so intermediate in its chemical characters between vegetable resin and asphaltum, that Mr. Hatchett has given it the very expressive name of retinasphaltum. It appears to be a vegetable resin, in which the change to amber, or to some analogous substance, is as yet so far incompleted that it retains the mixed character of both. The same, or a similar substance, has been found in other alluvial soils, as, for example, in the London clay (of Highgate): and my analysis proves this to be of the same chemical nature. In these instances, the incompleted change from resin to amber, or to a substance, at least, of which the distilled volatile produce would resemble naphtha, or the mineral essential oil, holds an exact parallel to certain of the cases in which the progress from brown coal, in the common vegetable fibre partially bituminized, can be traced down to perfect coal, or to a substance capable of yielding naphtha only on distillation.

It is from these analogies that we may, perhaps, safely conclude, that amber has been a vegetable resin converted to its present state, during the same time and by the same causes which have converted common vegetable matter into jet, and, perhaps, ultimately into coal.

That it is found in the same alluvial soils with jet, is, perhaps, too feeble an argument to deserve any weight; but it is also one which seems superfluous. Every circumstance which attends amber strongly bespeaks its vegetable origin; and nothing proves it more strikingly than that which forms the main object of this communication.

Art. VI. Lamarck's *Genera of Shells*

[Continued from Vol. XV. p. 258.]

2nd Division.

A constant varix on the right lip, in all the species.

8. Struthiolaria *.

Shell oval, spire elevated. Aperture oval, sinuous, terminated at the base by a very short, straight canal without any fissure. Left lip callous, expanded; right lip sinuous, reflected, with an external varix.

The struthiolaria is distinguished from buccinum, by having no notch at the base of the canal, and by the varix on the right lip. It has no other varix.

Type. *Struthiolaria nodulosa* †. (Murex stramineus. *Gmel.*) Shell ovate-conical, thick, transversely striated, white, with small wavy, longitudinal, yellow streaks; whorls angular at the top, flattened at the upper part, and nodular at the angle; sutures simple; interior of the lip reddish yellow. *New Zealand.* Pl. v. Fig. 130. 2 Species.

9. Ranella ‡.

Shell oval or oblong, subdepressed, channelled at the base; two rows of external varices. Aperture rounded, or sub-oval. Varices straight, or oblique, situated at the distance of half a whorl from each other and forming a longitudinal row on each side of the shell. They are sometimes smooth, sometimes tubercular, or spinous.

Distinguished from struthiolaria and murex, by the position of the varices, and the somewhat flattened form of the shell.

Type. *Ranella gigantea* §. (Murex reticularis. *Linn.*)

* From *Στρουθος*, *passer*, which signifies both a *sparrow* and an *ostrich*. The trivial French name for this shell is *pied d'autruche*, ostrich's foot.

† *Nodular.*

‡ Dim. from *rana*, a *frog*. § *Gigantic.*

Shell fusiform-turrited, ventricose, transversely sulcated and striated; white, clouded with red; furrows tubercular; the middle part of the last and penultimate whorl, surrounded by a single row of larger tubercles; beak ascending. *American Seas.* Pl. v. Fig. 181. 14 Recent species, and 1 fossil.

10. Murex*.

Shell oval or oblong, channelled at the base; rough, spinous or tubercular varices on the exterior surface. Aperture rounded, or sub-oval. Three or more varices on each whorl of the spire, the lower ones uniting obliquely with the upper in uninterrupted longitudinal rows. Operculum horny.

The Linnean genus murex comprehended a great variety of very different shells, confusedly jumbled together under one name. In it were found several of the cerithia, at least one pleurotoma, a turbinella, a cancellaria, two fasciolariæ, several fusi, and pyrulæ, struthiolaria, and ranella, murex proper, and some tritones. Bruguière reduced the murices to those shells which have constant external varices, and Lamarck has divided these further, into the three separate genera of ranella, murex, and triton, each containing a considerable number of species.

Of all the variciferous shells, the murex has the greatest number of varices, of which there are at least three, and frequently more, on each whorl; if we count those on the lowest whorl, we shall find that they coincide, though somewhat obliquely, with the varices of the upper whorls, the whole forming longitudinal rows on the shell, inclining towards one side, near the summit of the spire.

The struthiolaria has only one varix, which is on the right lip; the ranella two, at opposite sides of the shell; and the murex three, or more.

Type. *Murex brandaris* †. (Idem. *Linn.*)

Shell subclavate, anteriorly ventricose, caudate, whitish ash

* The name used by Virgil and Horace for the shell fish from which the Tyrian dye of the ancients was obtained; which, according to Columna was the *Purpura patula* of Lamarck; the *Buccinum patulum* of Linneus.

† Lamarck's second species. His type is *M. cornutus.*

colour; belly large, bifariately spinous; spines straight, channelled; spire rather prominent, muricate; beak naked towards its extremity. *Mediterranean* and *Adriatic*. Pl. v. Fig. 182. 66 Recent species, and two fossil.

11. Triton*.

Shell oval or oblong, channelled at the base; varices alternate, or rare, or nearly solitary, on the separate whorls, and never arranged in longitudinal rows. An operculum.

Sometimes the triton has only one varix, *viz*, that on the right lip, which is never wanting. The varices are generally smooth; never spinous.

Type. *Triton variegatum*†. (Murex Tritonis. *Linn.*)

Shell elongated-conical, trumpet-shaped, ventricose at the lower part, surrounded with very obtuse, smooth ribs; elegantly variegated, with white and red; edges of the sutures wrinkled; aperture red; columella with white wrinkles; and one plait on the upper part; margin of the lip spotted with black; spots terminated by two short white lines. *Asiatic Seas*. Pl. v. Fig. 183. 31 Species.

2d Family.

Alata. (3 Genera.)

A canal, of variable length, at the base of the aperture, the right lip of which changes its form by age, and has a sinus at the lower part.

A remarkable circumstance prevails in the shells of this family which is scarcely found in any others, except the cypræa, namely, the difference of form which exists between the young shell and the adult; so that the former has often very little resemblance to the latter.

Linneus considered all the alata as strombi, in which genus he has included shells that by no means belong to it. The essential

* A sea deity, the son of Neptune and Amphitrite.

† *Variegated*. Why our author has chosen to make this name *neuter*, we are at a loss to guess.

character of this family, (not noticed by Linneus,) consists in the singular developement of the right lip of the shell at a certain age of the animal, and especially, in a particular sinus which is constantly found near the base of that lip when it has acquired its full expansion. The operculum is horny, elongated and straight.

Lamarck divides this family, which contains the true strombi of Linneus, into three genera, founded on characters derived from the canal at the base, and from those of the right lip of the aperture.

1. Rostellaria*.

Shell fusiform, or subturrited, terminated at the lower part by a pointed, beak-shaped canal. Right lip entire, or toothed, more or less dilated by age, and having a sinus contiguous to the canal.

The right lip of these shells rests, at the upper part, against the elongated spire, and sometimes runs along it; but what especially characterizes this genus is that the sinus at the lower part of the same lip is quite contiguous to the canal, which is not the case, either with the pterocera or strombus.

Type. *Rostellaria curvirostris*†. (Strombus fusus. *Linn.*) Shell fusiform-turrited, very thick, heavy, smooth, very delicately striated transversely, reddish brown; whorls rather convex, the last obsoletely plicate; aperture white; edge of the lip toothed; beak rather short, curved. *Molucca Seas.* Pl. v. Fig. 184. 3 Recent species, and 3 fossil.

2. Pterocera‡.

Shell oblong oval, ventricose, terminated, at the lower part, by an elongated canal. Right lip dilated by age, into a digitated wing, the upper part of which rests against the whole spire; a sinus near its base. Spire short.

The canal at the base of the shells of this genus, is not shortened and truncated, as in the strombi, but elongated and caudiform, attenuated towards the extremity, and frequently closed. The sinus

* From *Rostellum*, a little beak.

† Curved beak. ‡ From *πτερον*, a wing, and *κερας*, a horn.

is not contiguous to the body of the shell, as in the rostellaria, but at a distance from it, as in the strombi, which differ from the pterocera, only in wanting the digitations of the dilated wing, and by their short canal.

The pterocera are generally large shells.

Type. *Pterocera lambis**. (Strombus lambis. *Linn.*)

Shell oblong oval, tubercular-gibbous, heptadactylous, variegated with red and brown; terminal digitations straight; spire acute conical; aperture very smooth, rosy. *Indian Seas.* Pl. v. Fig. 185. 7 Species.

3. Strombus†.

Shell ventricose, terminated at the base by a short, notched, or truncated canal. Right lip dilated by age into a simple wing, lobed or crenate at the upper part; on the lower part a sinus distinct from the canal or notch of the base.

Distinguished from pterocera by the dilated right lip not being divided by longitudinal digitations, as is the case with that shell, and by the canal at the base being very short, truncated, or notched: from rostellaria by the sinus being separated from the canal by a portion of the lip, whereas in the former it is contiguous to the canal.

Some strombi are of moderate size, even small, but some are very large and thick shells.

Type. *Strombus latissimus*‡. (Idem. *Linn.*)

Shell turbinated, ventricose, smooth on the back, with the wing subrugose; orange, spotted with white; spire short, nodular; lip very broad, rounded above, projecting beyond the spire, margin acute, side very thick; aperture smooth, white, with a rosy tint. *Indian Ocean.* Pl. v. Fig. 186. 32 Recent species, and 1 fossil.

* The term used by the old French conchologists for those strombi, which have large, projecting tubercles, and striæ on the external surface, and the aperture very smooth, and flesh-coloured. Thus, strombus gigas, was a *lampis*. *Dict. D'Histoire Naturelle.* Lamarck's second species—his type is *P. truncata.*

† Original Latin name for a sort of shell fish, from the Greek στρομβος.

‡ *Very broad.* Lamarck's third species—his type is S. *gigas.*

3d Family.

Purpurifera. (11 Genera.)

Shell with a short posteriorly ascending canal, or oblique notch or semi-canal at the base of the aperture, inclining towards the back.

The canal at the base of the aperture is almost lost in the shells of this family, most of them having merely an oblique notch, inclining backwards, and very perceptible when we examine the hinder part of the shell. They all appear to have opercula.

Lamarck has called this family *purpurifera*, because the trachelipoda which produce the shells it comprehends, especially those of the genus *purpura*, secrete, in a particular reservoir, the colouring matter from which the Romans formed their celebrated purple dye, the use of which has been superseded by the discovery of the cochineal.

The genera are separated into two subdivisions. 1. Those with the canal ascending, or curved towards the back. 2. Those with an oblique notch, inclining backwards. The former subdivision contains two, the latter nine genera.

1st Subdivision.

Canal ascending, or curved towards the back.

1. Cassidaria*.

Shell subovate, or oblong oval. Aperture longitudinal, narrow, terminated at the base by a curved subascending canal. Right lip varicose, or folded back; left lip covering the columella, generally rough, granular, tubercular, or wrinkled.

Distinguished from cassis by being, in general, less inflated than that shell, but chiefly by the short canal, which terminates the lower part of the aperture, not being abruptly turned towards the back of the shell, and by its also being only slightly curved, or ascending.

The spire of the cassidaria is short, conoidal, with convex whorls, and without any continuous varices. The left lip rests on the

* As allied to the *Cassis*.

columella, and is generally loaded with small, oblong, wrinkled tubercles, lying in a transverse direction, which assist in forming the character of these marine shells.

Type. *Cassidaria echinophora.* (Buccinum echinophorum. *Linn.*)

Shell ovate-globular, ventricose, banded, striated above and below, pale yellow; bands, four or five in number, tubercular; whorls of the spire angular; angles tubercular-crenate. *Mediterranean.* Pl. v., Fig. 187. 5 Recent species, and 2 fossil.

2. Cassis *.

Shell inflated. Aperture longitudinal, narrow, terminated at its base by a short canal, curved abruptly towards the back of the shell. Columella plaited, or wrinkled transversely. Right lip almost always toothed.

This genus is included by Linneus in his Buccina, from which it is distinguished by the longitudinal direction and narrow form of the aperture, by the right lip being toothed, by the flattening of the left or columellar lip, which generally projects considerably on that side, and by the abrupt reflection of the base of the canal towards the back of the shell. The true buccina have no canal, but merely a notch at the base of the aperture.

The spire of the cassis is but little elevated, and often interrupted by oblique cariniform varices. Lamarck uses these varices to divide the genus into two sections, those shells whose spires are furnished with them constituting one section, and those which are not, the other.

Type. *Cassis glauca* †. (Buccinum glaucum. *Linn.*)

Shell ovate, turgid, smooth, gray; the last whorl anteriorly subangular; spire striated, papillous, pointed; lip with four teeth at the base, internally brownish yellow. *Indian Ocean.* Pl. v. Fig. 188. 25 Recent species, and 1 fossil.

2nd Subdivision.

An oblique notch, inclining backwards.

* *A helmet.*

† *Gray.* Lamarck's sixth species; his type is *C. madagascariensis.*

3. Ricinula*.

Shell oval, generally tubercular or spinous externally. Aperture oblong, with a semi-canal at the lower part, curved towards the back, and terminated by an oblique notch. Unequal plaits on the columella and on the inner side of the right lip, usually contracting the aperture.

The Ricinulæ are generally small shells; the spire often low, and covered with tubercles or spinous points like the fruit of the ricinus. The aperture is generally tinged with purple or violet.

Type. *Ricinula horida*†. (Murex neritoideus. *Gmel.*)

Shell ovate, subglobular, covered with thick, short, acute, black tubercles; interstices white; spire very short; aperture ringent, violet coloured. *Indian Ocean.* Pl. v. Fig. 189. 9 Species.

4 Purpura‡.

Shell oval, smooth, tubercular, or angular. Aperture dilated, terminating below in an oblique, subcanaliculated notch. Columella flattened, pointed at the base.

This is the last genus whose shells present any appearance of a canal at the base of the aperture; they are distinguished by the dilated aperture, and the flattened and generally naked columella, terminating in a point at the base, whose notch turns a little upwards posteriorly.

Type. *Purpura persica*§. (Buccinum persicum. *Linn.*)

Shell ovate, transversely sulcated, rather rough, blackish brown; furrows obsoletely rugged, spotted with white; spire short; aperture dilated; columella brownish yellow, longitudinally excavated in the middle; interior margin of the lip sulcated, blackish, internally white, painted with brownish yellow lines. *Indian Ocean.* Pl. v. Fig. 190. 50 Species.

* Dim. from *Ricinus*, from the seed of one species of which, *R. communis*, the Castor Oil is procured.

† *Rugged.*

‡ *Purple*, applied, *κατ' ἐξοχὴν*, to this genus, for the reason already given. The term was also used, to denote this peculiar shell fish, by Pliny, Lib. 9, § 36.

§ *Persian.*

5. Monoceros *.

Shell oval. Aperture longitudinal, terminating below in an oblique notch. Columella generally flattened. A conical tooth at the interior base of the right lip.

The only distinguishing character between the monoceros and purpura, is the projecting, horn-shaped, conical tooth, on the right lip, which is constant in all the species.

Type. *Monoceros imbricatum* †. (Buccinum monodon. *Gmel.*)

Shell ovate, ventricose, rather rough, ash colour, or grayish red; ribs crowded, transverse, imbricate-squamous; whorls convex; spire short; lip crenate. *Straits of Magellan.* Pl. v. Fig. 191. 5 Species.

6. Concholepas.

Shell oval, inflated, semi-spiral; summit inclined obliquely towards the left margin. Aperture ample, longitudinal, oblique, with a slight notch at the lower part. Two teeth at the base of the right lip. Operculum oblong, thin, horny.

This singular genus, of which only one species is known, was formerly classed with the patellæ. Bruguières, in consequence of the notch at the lower part of the aperture, and from its having an operculum, perceived that it differs materially from the shells of that genus, and placed it with the buccina, but its peculiar characters forbid its being associated with either the one or the other, or, indeed, with any known genus. Lamarck has, therefore, made it a separate genus, and ranged it next to the monoceros, it having two teeth at the base of the right lip, instead of only one.

One Species. *Concholepas peruvianus* ‡. (Patella lepas. *Gmel.*)

The usual specific characters are omitted, but the author states below, that the shell is of moderate size, the spire incomplete, depressed towards the margin, and furrowed longitudinally. The

* *Unicorn*, from μονος, one, and κερας, a *horn.* † *Imbricated—disposed in plates, lying one over another, like the tiles of a house.* Lamarck's second species; his type is *M. cingulatum.*

‡ *Peruvian.*

two teeth on the right lip are short and obtuse. The left lip resembles a flattened columella. *Coasts of Peru.* Pl. v. Fig. 192.

7. Harpa*.

Shell oval, more or less inflated, with parallel, inclined and sharp longitudinal ribs. Spire short. Aperture notched at the lower part; no canal. Columella smooth, flattened and pointed at the base.

Linneus comprehended almost all the harpæ, under the name of *buccinum harpa*, considering them as forming only one species. But although they agree in the common character, that all have external, longitudinal, parallel, compressed, inclined and sharp ribs, and that the upper extremity of each rib forms a small, detached, projecting point, there are, nevertheless, constant peculiar characters, which distinguish the several species. They are principally found in hot climates.

Type. *Harpa ventricosa*†. (Buccinum harpa. *Linn.*)

Shell ovate, ventricose; ribs broad, compressed, tinged with purple, pointed at the apex, with one tooth below the point; interstices whitish, marked with curved, reddish-brown spots; columella spotted with purple and black. *Indian Ocean.* Pl. v. Fig. 193. 8 Recent species, and 1 fossil.

8. Dolium‡.

Shell thin, ventricose, inflated, generally subglobular, rarely oblong; transversely banded; right lip toothed, or crenate through its whole length. Aperture oblong, notched below.

Linneus, and other naturalists, considering only the notch at the base of the aperture, have confounded the dolium, harpa, terebra, eburna, *&c.*, with the buccina, notwithstanding their great differences in point of general form, and the distinct characters by which nature has arranged them in separate groups, all of which are thus made to fade away, before the insulated circumstance of a notch at the base of the shell.

* *A harp.*

† *Ventricose.* Lamarck's second species; his type is *H. imperialis.*

‡ *A tun.*

The dolium is distinguished from the harpa, and the other shells just alluded to, by having no longitudinal ribs, by their ventricose, inflated and subglobular form, the spire being much shorter than the lower whorl, whence the aperture is very large, and always occupies more than two thirds of the length of the shell. Although thin, some of these shells attain a very large size. They are all encircled externally by transverse bands, which render the margin of the right lip crenate, from one end to the other.

Type. *Dolium perdix**. (Buccinum perdix. *Linn.*)

Shell oblong-ovate, inflated, thin, reddish yellow, marked with rows of white, crescent-shape spots ; ribs rather convex, crowded ; spire slightly prominent, conical. *Indian Seas.* Pl. v. Fig. 194. 7 Species.

9. Buccinum †.

Shell oval, or ovate conical. Aperture longitudinal, with a notch at the base, but no canal. Columella not flattened, turgid at the upper part.

The numerous species of which this genus still consists, although much reduced by the separation of the harpæ, dolia, &c., present considerable differences of aspect ; they are, however, all connected by great leading characters.

The buccina are marine, shore shells, the greater part very small, though some species attain a mean, or ordinary size. Those which have a callous columella, Lamarck had separated into a distinct genus, under the name of nassa, but he has since reunited them to the buccina.

Type. *Buccinum undatum* ‡. (Idem. *Linn.*)

Shell ovate-conical, ventricose, transversely sulcated and striated, and decussated with very delicate longitudinal striæ ; longitudinally plicate ; whitish, or yellow gray ; folds thick, oblique, wavy ; whorls convex ; aperture white or yellow. *Seas of Europe.* Pl. v. Fig. 195. 58 Recent species, and 2 fossil.

* *Partridge.* Lamarck's seventh species; his type is *D. galea.*

† *A trumpet.* The term is also used by Pliny, to denote a certain shell fish.

‡ *Wavy.*

10. Eburna*.

Shell oval, or elongated; right lip very simple. Aperture longitudinal, notched at the base. Columella umbilicated at the upper part, and channelled below the umbilicus. Distinguished from buccinum by the singular position of the umbilicus of the columella, and, especially, by its being produced at the lower part so as to form a canal, which occupies the rest of the left lip. In other respects the eburnæ resemble the buccina in their general form, and by the notch at the base of the aperture. Their exterior surface is smooth, and polished.

Type. *Eburna glabrata*†. (Buccinum glabratum. *Linn.*)

Shell elongated, oval, bisulcated at the base, very smooth, polished, pale brownish yellow; whorls slightly convex, confluent at the upper part; sutures obsolete. *American Ocean.* Pl. v. Fig. 196. 5 Species.

11. Terebra‡.

Shell elongated, turrited, very pointed at the summit. Aperture longitudinal, many times shorter than the spire, and notched at the posterior part of the base. Base of the columella twisted, or oblique.

The very short columella of this shell presents a peculiar character; in its general form it much resembles the turritella, but is distinguished from that genus by its aperture, and by the notch at the posterior part of the base; from the eburnæ, by not having the channelled umbilicus, and from the buccina, by the small proportion which the length of the aperture bears to that of the spire of the shell.

Type. *Terebra maculata*§. (Buccinum maculatum. *Linn.*)

Shell conico-subulate, thick, heavy, smooth, white, surrounded with rows of bluish brown spots; towards the base spotted with pale brownish yellow; whorls rather flattened. *Pacific Ocean.* Pl. v. Fig. 197. 24 Species.

* From *Ebur*, ivory. † *Smooth.* ‡ *An auger.*
§ *Spotted.*

4th Family.

COLUMELLARIA. (5 genera.)

No canal at the base of the aperture, but a more or less distinct subdorsal notch, and folds on the columella.

The shells of this family are entirely without any canal; their essential characters are the plaited columella, and the notch at the base of the aperture.

1. Columbella*.

Shell oval, spire short: base of the aperture more or less notched; no canal. Columella plaited. Aperture contracted by a swelling on the inner side of the right lip.

The shells of this genus are short, small, and of considerable thickness; often striated transversely, and of very various colours. They are marine, shore shells, and are distinguished from the volutæ, by the swelling on the inner side of the right lip, and by their having a small operculum.

Type. *Columbella mercatoria*†. (Voluta mercatoria. *Linn.*)

Shell ovate-turbinated; transversely sulcated, white, painted with small, reddish brown, transverse, subfasciculated lines, sometimes banded; lip toothed within. *Coasts of Goree.* Pl. v. Fig. 198. 18 Species.

2. Mitra‡.

Shell turrited, or subfusiform; spire pointed at the summit; base notched; no canal. Columella transversely plaited; plaits parallel, the lower ones the smallest. Columellar lip thin, and resting on the columella.

Distinguished from the volutæ, by the summit of the spire being quite pointed, and not terminated by a mammella, and by the columellar plaits gradually lessening towards the base. The columellar lip is sometimes visible only near the base of the columella. The mitræ are found in the seas of warm climates; they are agreeably varied in their colours, and sometimes are covered with an epidermis. They probably have no operculum.

* Dim. from *columba, a dove?* † *Connected with traffic.*
‡ *A Mitre.*

Type. *Mitra episcopalis* *. (Voluta episcopalis. *Linn.*)

Shell turrited, smooth, white, spotted with red; the lower spots square, disposed in regular order, transversely; the upper irregular; superior margin of the whorls entire; columella quadriplicate, lip toothed posteriorly. *Indian Ocean.* Pl. v. Fig. 199. 80 Recent species, and 14 fossil.

3. Voluta †.

Shell oval, more or less ventricose; summit obtuse, or mamellated; base notched; no canal. Columella plaited; lower plaits largest, and most oblique. No columellar lip.

Bruguières began the reform of the too numerous genus voluta, as established by Linneus, by removing from it all the shells which have no notch at the base. Lamarck has carried it still further, by separating from it the mitræ, columbellæ, marginellæ, cancellariæ and turbinellæ. The genus still contains a great number of species, many of which are remarkable for the variety, beauty, and vivacity of their colours. They are generally smooth and brilliant, and do not appear ever to be covered with an epidermis. Some of them are very ventricose, others simply oval, and covered with tubercles; others again are ovate-conical, elongated, almost fusiform, or turrited, and approach the shape of the mitræ. They are all marine shells, and generally inhabit the seas of hot climates. No species of this genus is found in our seas.

The volutæ are distinguished from the mitræ by the lower plaits on the columella being larger than the upper, and by the obtuse and mammellated termination of the spire.

Lamarck separates them into four subdivisions, viz.—1. *cymbiolæ*, ventricose shells. 2. *Muricinæ*, oval, spinous, or tubercular. 3. *Musicales*, oval, subtubercular. 4. *Fusoideæ*, elongated, ventricose, subfusiform.

Type. *Voluta Diadema* ‡. (Voluta æthiopica-var. *Linn.*)

Shell ventricose, orange yellow, sometimes marked with white;

* *Episcopal.* † *Volute.*

‡ *Diadem.* Lamarck's second species of the first subdivision. His type is *V. nautica.*

spire crowned with arched, pointed, nearly straight spines; columella triplicate. *Asiatic Seas.* Pl. v. Fig. 200. 44 Recent species, and 18 fossil.

4. Marginella *.

Shell oblong oval, smooth; spire short; right lip externally varicose; base of the aperture very slightly notched. Columella plaited; plaits nearly of equal size.

The marginellæ are generally smooth, polished shells, prettily coloured, and remarkable for the varix, or projecting callus on the right lip of the aperture. They are distinguished from the mitræ and volutæ by the equal folds on the columella, by the aperture, which almost always occupies the whole length of the shell, by the callus on the right lip, and by the scarcely perceptible notch at the base of the aperture. They inhabit the seas of warm climates.

Lamarck subdivides the genus into, 1, shells with a projecting spire; and, 2, those without a projecting spire.

Type. *Marginella glabella* †. (Voluta glabella. *Linn.*)

Shell ovate oblong, grayish yellow, surrounded with reddish zones, sprinkled with very small white spots; spire short, conical; apex obtuse; columella quadriplicate. *Senegal.* Pl. v. Fig. 201. 25 Species.

5. Volvaria ‡.

Shell cylindrical, convolute; spire scarcely projecting. Aperture narrow, as long as the shell. One or more plaits on the lower part of the columella.

Distinguished from marginella by having, in general, no varix on the outer lip, which is thin and sharp, though sometimes slight traces of a varix are perceptible. The volvariæ are all sea shells, and generally of small size.

Type. *Volvaria bulloides* §.

* From *margo*, a *margin*, in allusion to the varix on the right lip.

† Dim. from *glaber*, *smooth*, or *bare*. ‡ From *volvo*, to *roll*.

§ *Like a bulla.* We have chosen this, though fossil, and the last of Lamarck's species, for our type, as most perfectly answering the characters of the genus, and as being the individual on which he originally established it. See his System, 1801.

Shell cylindrical, transversely striated: striæ dotted; spire nearly concealed in the folds of the shell, pointed; base of the columella triplicate. Fossil, from Grignon. Pl. v. Fig. 202. 5 Recent species, and 1 fossil.

5th Family.

CONVOLUTA. (6 genera.)

No canal; base of the aperture notched, or effuse; whorls of the spire wide, compressed, convolute, the last whorl almost entirely covering the others.

The convoluta constitute the last family of the trachelipoda Like the columellaria, their shell has no canal at the lower part, but a notch at the base of the aperture. The most remarkable thing in regard to their form, is the great width of the whorls, so that the last almost wholly envelopes all the rest. Hence the spiral cavity of the shell is long and narrow, and the body of the animal must, consequently, be considerably flattened.

The shells of the two first genera have the right lip of the aperture curved inwards.

1. Ovula *.

Shell inflated, attenuated or subacuminated at each end; lips curved inwards. Aperture longitudinal, narrow, effuse at the extremities; left lip not indented.

Linneus confounded the ovulæ with his bullæ, from which they were first distinguished by Bruguières. They are closely allied to the cypræae, in point of form; are sometimes rostrated at both ends, nearly smooth, and have no spire. They are distinguished from the cypræae, by the left lip never having any indentations, and from the bullæ, by the turning inwards of the right lip.

The shells of this genus never have a lamina resting on the columellar lip, which is always naked, smooth, and more or less inflated. They have neither epidermis nor operculum.

Type. *Ovula oviformis* †, (Bulla ovum. *Lin.*)

* Dim. from ovum, an egg.

† *Egg-shaped.* Lamarck divides the species into two sections, viz., those with the right lip plicated, and those in which it is smooth.

Shell inflated, oval, ventricose in the middle, smooth, milk white; extremities rather prominent, subtruncated; mouth orange. *Moluccas.* Pl. v. Fig. 203. 12 Recent species, and 2 fossil.

2. Cypræa.

Shell oval, or oblong oval, convex on the upper part, somewhat flattened at the under; lips curved inwards. Aperture longitudinal, narrow, indented on both sides, effuse at each end, and extending the whole length of the shell. Spire very small, scarcely perceptible.

The cypræeæ are generally smooth shining shells, agreeably coloured, and without any epidermis. They are remarkable for the different appearance which the shell of the same individual assumes at different periods of its growth. In the mature state, these shells answer the description given above, but when young, they have a very different form. The aperture is then more dilated, especially at the lower part, is entirely without indentations, and the right lip is sharp. In its next, or middle, stage of growth, it acquires the general form of the adult shell, but is still incomplete, having only its first superimposed layer of testaceous matter, and the spire, though very small, is not yet entirely covered; its colours, moreover, are still wanting. The second layer of testaceous matter, variegated with the brilliant colours that adorn this genus, is deposited by two membranous expansions of the mantle of the animal, which it spreads over the back of the shell, so as to cover and conceal it completely, thus adding at once to its solidity and beauty. In some species, the place where the two edges of the mantle meet, is marked by a longitudinal line, on the back of the shell, of a different colour from the rest of it.

From the varying form of this shell, according to its age, we must be careful to distinguish the three separate states in which it is likely to be met with, or we shall be liable to mistake the same individuals for three distinct species.

In some species the place of the spire presents a little pit, similar to an umbilicus, in others it is almost obliterated. In like manner the two external margins of the shell are sometimes both

dilated, sometimes only one; and again, sometimes neither of them are prominent or inflated.

Lamarck states that observation has proved that the animal of the cypræa continues to grow after it has completed its shell, which it is consequently obliged to quit, and form a new one; hence the same individual may form several shells with a single layer of testaceous matter, and several with the layers double, or complete; and this he thinks is proved by the fact that perfect shells of the same species are often found of different sizes.

The head of the animal which inhabits the cypræa, is furnished with two slender conical tentacula, finely pointed, with the eyes situated near the base on the outer side. The tube for respiring water is short, and placed on the neck; it is formed by the anterior part of the mantle, and lodged in the notch of the shell which terminates the aperture on the side next the spire. The foot of the animal is a ventral, fleshy, linguiform disc, which it uses for the purposes of locomotion.

The cypræe live buried in the sands, at some distance from the sea coast, both in hot and temperate climates. The different species, which are very numerous, are not easily distinguished from each other, for their individual characters, independent of the colours of the shell, are few.

Type. *Cypræa cervina**. (Cypræa oculata. *Gmel.*)

Shell ovate-ventricose, yellow or chesnut colour, sprinkled with small, very numerous, whitish spots; longitudinal dorsal line straight, light coloured; interior of the lip inclining to violet. *American Seas.* Pl. v. Fig. 204. 6?? ecent species, and 18 fossil.

3. Terebellum†.

Shell convolute, subcylindrical, pointed at the summit. Margin simple, and acute. Aperture longitudinal, contracted at the upper part, notched at the base. Columella smooth, truncated at the bottom.

The genus bulla, observes Lamarck, seems to have been a pro-

* *Belonging to a stag*, from the colour of the shell. † *A little auger.*

visional receptacle, in which Linneus placed all the univalve shells, whose classification puzzled him; thus he considered the terebellum to be of the same genus as *ovula*, *bulla proper*, *achatina*, certain *pyrulæ*, &c., in spite of the disparity of these associations.

The terebellum has no epidermis, it is a thin, smooth shell, and when we look at its back, appears to be irregularly notched at the base. It most resembles the ancillaria, oliva, and conus, and has some slight similitude to the young cypræa.

Type. *Terebellum subulatum* *. (Bulla terebellum. *Linn.*)

Shell cylindrical-subulate, thin, smooth, delicate; spire distinct; left lip resting on the columella. *Indian Ocean.* Pl. v. Fig. 205. 1 Recent species, and 2 fossil.

4. Ancillaria †.

Shell oblong, subcylindrical; spire short, not channelled at the sutures. Aperture longitudinal, scarcely notched at the base, effuse. A callous, oblique varix at the base of the columella.

The ancillaria has great resemblance to the oliva, but the upper edges of the whorls of the spire rest, each respectively, against the preceding whorl, and are not separated from it by a spiral canal, as is the case with the olivæ. The callous, oblique varix, at the base of the columella, distinguishes this genus from terebellum and buccinum.

The aperture of the ancillariæ is longitudinal, but never extends through the whole length of the shell. They are sea shells, and more numerous in fossil than in recent species.

Type. *Ancillaria cinnamomea* ‡.

Shell oblong, ventricose-cylindrical; chesnut yellow; a light coloured or whitish band on the upper part of the whorls; columellar varix red, substriated. (Locality not given.) Pl. v. Fig. 206. 4 Recent species, and five fossil.

5. Oliva §.

Shell subcylindrical, convolute, smooth; spire short, sutures channelled. Aperture narrow, longitudinal, and notched at the base. Columella obliquely striated. No operculum.

* *Awl-shaped.* † From *ancilla*, a damsel. ‡ *Cinnamon colour.* § *An olive.*

The olivæ are very smooth shells, shining, and prettily coloured, and have no epidermis. They are distinguished from the cylindrical cones, by the channel which separates the whorls of the spire, and by the striæ on the columella; from voluta and mitra, by the spiral whorls of those shells being separated by simple unchannelled sutures. The oliva is further distinguished by a prominent callus at the upper extremity of the columellar lip, which assists in forming the channel of the spire. At the base of the columella some vestiges of the very oblique callus of the ancillariæ appear, but those shells never have their sutures channelled, nor a striated columella.

The shell of the oliva is rolled round the longitudinal axis, leaving a void space at the place of the axis, and the last whorl so envelopes the rest, that only their upper portion is visible, and consequently the spire is very short. The shell appears to be formed of two separate layers of testaceous matter, like that of the cypræa, for if we remove the exterior layer, we generally find the one beneath of a different colour. Hence, during the life of the animal, the shell is probably frequently covered by the mantle, though no dorsal line, indicating the junction of the lateral lobes of the mantle, as on the cypræa, can be distinguished on the oliva.

Linneus not only did not distinguish the olivæ from his volutæ, but even considered almost all of them as mere varieties of one species, viz., *voluta oliva.* This genus, however, is well defined by the characters we have given above, though the discrimination between the several species is somewhat difficult.

The olivæ, are found in the seas of warm climates; the head of the animal inhabitant is furnished with two long, pointed tentacula, towards the middle of which, are placed its eyes. A tube, situated above the head, conveys the water to the branchiæ.

Type. *Oliva porphyria**. (Voluta porphyria. *Linn.*)

Shell large, light flesh colour, spotted with red, and adorned with red angular lines; spire and base tinged with violet. *South American Seas.* Pl. v. Fig. 207. 62 Recent species, and 5 fossil.

* *Of porphyry.*

6. Conus *.

Shell turbinated, or inversely conical, convolute. Aperture longitudinal, narrow, not toothed, effuse at the base.

This genus is the most beautiful, extensive, and interesting of all the spiral, unilocular univalves. It contains the most costly and remarkable shells, whether from the regularity of their form, or the brilliancy and variety of their colours. The most striking character of the cones is that the whorls of the spire are, as it were, compressed, and rolled one on another, cornet-fashion, so as to leave only the outer whorl wholly visible, and merely the superior margin of all the interior ones. Their general form is that of an inverted cone, being smallest at the base, and increasing in diameter towards the spire, which is usually short, sometimes flattened, sometimes slightly convex, and occasionally somewhat conoidal. The cones inhabit the seas of hot climates, at the depth of ten or twelve fathoms: the animals of this genus breathe only by the branchiæ; their head is furnished with two tentacula, which have eyes near their summit. The mantle is narrow, and above the head is a tube, to convey the water which they breathe to the branchiæ. The cones are all sea shells.

Type, *Conus marmoreus* †. (Idem. *Linn.*)

Shell oblong, turbinated, black, with white, subtriangular spots; spire obtuse, crowned with tubercles; whorls with concave channellings. *Asiatic Seas.* Pl. v. Fig. 208. 181 Recent species, and 9 fossil ‡.

Fourth Order.

CEPHALOPODA.

Mantle in form of a sac, containing the lower part of the body. Head projecting beyond the sac, crowned with inarticulated arms, furnished with suckers, and surrounding the mouth. Two

* *A cone.* † *Of marble.*

‡ Besides the fossil species described at the end of the several genera, and briefly noticed in the preceding pages of these extracts, Lamarck has added a supplement, in this part of the work, containing the descriptions of many others, which the geologist will find very useful in his researches in fossil conchology.

sessile eyes; two horny mandibles at the mouth; three hearts; sexes separate.

The *cephalopoda*, have been so named by M. Cuvier, because the head of each animal is furnished with a kind of inarticulated arms, forming a coronet round the mouth, which is terminal.

Except of the family of the *sepiaria*, and of the genus *spirula*, we know little of the animals of the families and genera included in this order, most of them inhabiting the great depths of the sea, and, consequently, being beyond the reach of our observations. From those which are known to us, we can ascertain that the cephalopoda are the most perfect of the mollusca; their organization is the most complicated, and most developed, and they are in this respect, superior to the other invertebrated animals.

The body of the cephalopoda is thick and fleshy, and its lower part contained in a muscular sac, formed by the mantle of the animal. This mantle, closed at the posterior part, is only open at the upper, from which the head and a portion of the body projects. The head is free, surrounded by a coronet of tentacular arms, the number and size of which vary in the different genera. It has at the sides two large, sessile, immoveable eyes, without eyelids, but very complicated with regard to their humours, membranes, vessels, &c. The mouth of these animals is terminal, vertical, and armed with two strong horny mandibles, which are hooked, and resemble a parrot's bill. Lastly, the organ of hearing, although unprovided with any external conduit, as in fishes, is distinguishable in these mollusca.

The cephalopoda are furnished with three hearts for the circulation of the fluids; or, perhaps we should rather say, they have but one heart, and two separate lateral auricles. In fact, the principal trunk of the veins, or that which carries the blood, divides into two branches, which convey the fluid to the lateral auricles; these send it to the branchiæ, whence it is carried to the true heart, situated in the middle, and from thence over the whole body, by means of the arteries.

These mollusca all live in the sea; some swimming about freely, and fixing themselves to marine substances at pleasure, the others

crawling on the bottom, or along the shores, by the assistance of their arms. Most of the latter conceal themselves amongst the rocks. They are all carnivorous, and prey on crabs and other marine animals. The position of their arms admirably facilitates the conveyance of the food to the mouth, whose strong mandibles serve to crush the hard bodies which the animal seizes on. Some of the cephalopoda are quite naked, others inhabit a thin, unilocular shell which envelopes them, and which they can cause to float on the surface of the water: others, again, are provided with a multilocular shell, either wholly, or in part internal.

These latter are very numerous, and singularly diversified in regard to form; the ocean, especially at great depths, seems filled with them, so great is the multitude of fossil multilocular shells, met with in the older formations. With the exception of some species of a pretty large size, the greater part of these shells are extremely minute.

The shells of those cephalopoda which are furnished with them, afford but little instruction from their form, as to that of the animals which produced them. To distinguish these shells we can only compare them with one another; and we are as yet ignorant whether the divisions we may thus establish, will coincide with the principal divisions we should form of the mollusca themselves, if we had the opportunity of being better acquainted with them.

The multilocular shells of this order, are extremely remarkable from their diversity of form, and have hitherto greatly embarrassed naturalists in their attempts to determine the relation of the animals which produce them, to the known conchiferous mollusca. The manner in which these shells were formed, their connexion with the animal, whether it inhabit the last chamber of the shell, be wholly, or only in part contained in it, or whether the shell be more or less completely internal, were all questions which we had no means of determining, till MM. Sueur and Peron, brought the animal of the *spirula* from New Holland. This animal is a true cephalopoda, and has a multilocular shell inserted in the posterior part of its body, only a portion of the shell being visible; hence we may confidently presume that all multilocular shells, or those which are

essentially so, actually belong to cephalopodous mollusca, and are more or less internal.

Lamarck divides the cephalopoda into three sections.

First Section. Testaceous, polythalamous cephalopoda. Shell multilocular, subinternal.

Second Section. Testaceous, monothalamous cephalopoda. Shell unilocular, wholly external.

Third Section. Naked cephalopoda. No shell, either internal or external.

Section I.

Polythalamous Cephalopoda.

Shell multilocular, wholly or partly enveloped, inserted in the posterior part of the body of the animal, often adhering.

It appears that the shell of the polythalamous cephalopoda contains the posterior part of the body of the animal, or a portion of that part, in its last chamber; but the shell itself is incased in the posterior extremity of the body, and either entirely or partially covered by it.

In the *spirula*, about a fourth part of the shell is visible, or exterior to the body of the animal. In the nautilus, probably, two-thirds of the shell are uncovered, the rest being enveloped by the posterior part of the Cephalopoda.

The *nummulites*, and the other minute multilocular shells are, on the contrary, probably wholly enveloped and hidden by the posterior part of the animal which produces them; and, perhaps, the same may be the case with the *ammonites*, although many of those shells are of very large size.

Some of the animals of this section appear to contain their shell without adhering to it, whilst others adhere by means of a tendinous filiform ligament lodged in a sheath, which traverses the chambers of the shell, and which increases in length in proportion as the animal displaces the enveloped portion of its body; for, as the animal grows, the last chamber of the shell must become too small for the part contained in it; it, therefore, probably withdraws that part to some distance from the last chamber, leaving a void

space behind, and remaining stationary for a while in its new position, forms another and a larger chamber.

This section contains seven families. The shell is multilocular, and the margins of the chambers are simple, without any divided sinuous sutures on the internal surface of the shell.

1st Family.

ORTHOCERATA *, (5 genera.)

Shell straight, or nearly so; no spiral.

The shells of this family, as its name denotes, are straight, or only very slightly curved, and consist of an elongated, testaceous envelope, containing a similarly elongated nucleus. When the envelope is solid at the upper part, so that the nucleus does not reach its summit, they are easily separated from each other. The chambers of the nucleus are simple, and generally perforated. Most of the shells of this family are unknown except in the fossil state.

1. Belemnites †.

Shell straight, elongated-conical, formed of two distinct and separable parts; *viz.*

The external, a solid sheath, full at the upper part, with a conical cavity;

The internal, a conical nucleus, pointed, chambered transversely through its whole length, multilocular; chambers slightly concave on one side, and convex on the other, and perforated by a central siphon.

The belemnites, which are only found fossil, and generally empty, or without the nucleus, are merely the sheath of an elongated-conical mass, not adhering, chambered, and furnished with a siphon like the orthocera and hippurites. The form of the sheath is that of a long cone, more or less pointed at the summit, and it often has a shallow lateral groove; its upper part is solid, whilst the lower has a conical cavity, which contains the multilocular nucleus.

Type. *Belemnites subconica* ‡. (Nautilus belemnita. *Gmel.*)

* From ορθος, *straight*, and κερας, a *horn*.

† From βελος, unde βελεμνον, a *dart*.

‡ *Subconical.*

Shell semicylindrical at the lower part; the upper part attenuated, conical. Fossil—common in limestone, *&c.* Pl. vi. Fig. 209. 2 Species *. (This figure shews the slender process at the apex of the cone, mentioned in the note below; Fig. 209 is a representation of another, and rarer species, *B. mamillata.*)

2. Orthocera.

Shell elongated, straight, or slightly curved, subconical, striated

* In the Transactions of the Royal Society of Edinburgh, for 1823, is a very interesting paper by Thomas Allan, Esq., on the "Formation of the Chalk Strata and Structure of the Belemnite," to which we refer the reader for much valuable information respecting this curious fossil. Amongst other particulars mentioned by Mr. Allan, and which we wish our limits did not forbid us to quote more in detail, he observes that, "The form of the belemnite is that of a cylinder, terminated at one end with a conical point, *furnished with a slender process of about a quarter of an inch in length;* but it is only when the belemnite has been enclosed in flint that this delicate member has been preserved."—"*This process proceeds from the apex of the cone, to that of the belemnite.*"—"In composition, the belemnites, whether enclosed in lime-stone, flint, clay, or sand-stone, is uniformly formed of crystallized carbonate of lime, striated and radiating to the circumference, from a lime which passes from the apex of the alveolus to that of the fossil."—"A structure quite different from that of other calcareous fossils, which are formed in general of the common rhomboidal carbonate;" and, "which appears to have been dependent on some internal organization."—"On this account we may, perhaps, be allowed to consider the belemnite as unaltered." Mr. Allan dissected several belemnites imbedded in flint, from Ireland, by means of acid, and found them intersected by minute siliceous cylinders, having exactly the form and appearance of arteries, and connected with each other and with that portion of the cone which remained, by means of smaller fibres representing veins, and affording the most striking resemblance to an injected anatomical preparation." Others, when the calcareous matter was removed, exhibited "small, irregular, globular masses, entangled in "lace-like work," and in others, again, the flint presented an appearance "which may, perhaps, be best compared to the ovarium of some animal." Mr. Allan decides nothing as to the mode by which the siliceous matter may have been introduced into the fossil. Perhaps they may be worm-holes filled up with the flint;—"the great dissimilarity among the specimens seems to preclude the possibility of attributing their structure to organization, however strongly some of them may resemble it." The slender process, however, projecting from the apex of the concamerated cone to that of the belemnite, appears to be uniform; and, perhaps, the "anatomist may find in the threads by which the rounded masses (in the ovarium-like specimens) are connected, more uniformity than could be attributed to the accidental perforations of a worm." These various appearances are beautifully represented in two plates annexed to this valuable communication.

externally by numerous longitudinal ribs. Chambers formed by transverse septa, perforated by a central or marginal tube.

The orthocera is a very small marine shell, resembling a straight or slightly arched horn; the subcentral siphon which traverses the interior transverse septa, often projects at each extremity of the shell, or only at one end. These small shells are found, with many others, in the sand on the shores of the Mediterranean.

Type. *Orthocera raphanus**. (Nautilus raphanus. *Linn.*)

Shell straight, elongated-conical, articulated; articulations torose; siphon sublateral. *Shores of the Mediterranean.* Pl. vi. Fig. 210. 6 Species.

3. Nodosaria †.

Shell elongated, straight or slightly arched, subconical, nodular; nodules globular, very smooth. Chambers formed by transverse septa, perforated in the centre or near the margin.

The nodosaria differs from the orthocera by having only smooth, globular nodules on the external surface, without the small longitudinal ribs which give the latter shell a channelled appearance.

Type. *Nodosaria radicula* ‡. (Nautilus radicula. *Linn.*)

Shell straight, oblong-attenuated; articulations globular, smooth; siphon sublateral. *Adriatic.* Pl. vi. Fig. 211. 3 Species.

4. Hippurites §.

Shell tubular, cylindrico-conical, straight or slightly curved, thick, multilocular; septa transverse. An internal lateral canal formed by two longitudinal, obtuse, converging edges. The last chamber closed by a thick, solid operculum; edges of the operculum bevelled, and accurately adjusted to the orifice of the chamber.

Some hippurites have a siphon which traverses the septa from end to end, without communicating at all with the chambers of the tube; in others, the siphon is replaced by a lateral canal sometimes hollow, but most commonly filled by the same septa that traverse the cavity of the tube; others, again, have both the siphon and canal. Those with the canal are always thicker than the

* *A radish.* † From *nodus*, a knot.
‡ *A little root.* § From Hippuris, *the herb called mare's tail?*

others. These shells are only known in the fossil state, and were discovered in the Pyrenees, by the late M. Picot de la Peyrouse.

Type. *Hippurites rugosa* *.

Shell cylindrical, attenuated, very thick, transversely rugose; base truncated; a double pit in the truncation. Fossil, from the Pyrenees. Pl. vi. Fig. 212.

5. Conilites †.

Shell conical, straight, slightly bent; sheath thin, distinct from the contained nucleus. Nucleus subseparable, multilocular, divided by transverse septa.

The conilites appears to differ from the belemnites, principally in not having the upper portion of the sheath, or external shell, elongated and solid, (in consequence of the termination of the cavity for the nucleus before it reaches the summit,) as in those shells. The nucleus seems also to be less easily separated from the sheath than that of the belemnites.

One species. *Conilites pyramidata* ‡.

Shell conico-pyramidal; lower face concave. Fossil, *Coast of Britany*. Pl. vi. Fig. 213.

2d Family.

LITUOLATA, (3 genera.)

Shell partly spiral; the last whorl straight.

The lituolata are multilocular shells, of a spiral form, but the last whorl terminates in a straight line. The transverse septa, which form the chambers, are generally traversed by a siphon, which is interrupted before it reaches the succeeding septum. The whorls which form the spiral are, sometimes, distant from one another, leaving a remarkable space between them; sometimes they are quite close together; in either case, the last always ends in a straight line. Some have the last septum pierced with from three to six holes, as if their siphon were compound.

1. Spirula §.

Shell cylindrical, thin, almost transparent, white or pearl colour, multilocular, partly twisted into a discoidal spiral; whorls distant

* *Rugose.* † From *conus, a cone.*
‡ *Pyramidal.* § *A little spire.*

from one another, the last produced in a straight line. Septa transverse, placed at equal distances from each other, externally concave; siphon lateral, interrupted. Aperture orbicular.

The animal of the spirula, which was brought with its shell, from the South Seas by M. Peron, is a true cephalopoda. The posterior part of the body is enveloped by a sac, the anterior projects beyond it, and the head sustains six arms, disposed like a coronet, round the mouth, two of which are longer than the rest. At the posterior end of the sac, is an incased shell, only a portion of whose last whorl is uncovered and visible. In consequence of this important discovery, Lamarck thinks himself justified in assuming that all the multilocular shells, belong to the cephalopoda.

One Species. *Spirula Peronii**. (Nautilus Spirula, *Linn.*)

The diameter of the disc of the shell seldom exceeds an inch. No further description. *South Seas.* Pl. vi. Fig. 214.

2. Spirolinites.

Shell multilocular, partly twisted into a discoidal spiral; whorls contiguous, the last terminating in a straight line. Septa transverse, perforated by a tube.

Distinguished from spirula by the contiguity of the whorls. Only known in the fossil state; very small shells; the straight part of the last whorl, bears a considerable proportion to the spiral part. Some species have only an incipient spiral at the summit, the rest of the shell being straight; others are quite straight, like certain individuals of the genus orthocera; in some the shell is flattened, in others cylindrical. In all, the septa form little external projections, which divide the spiral tranversely, as by so many separate ribs or striæ. The siphon, which traverses the septa and chambers, is very distinct, notwithstanding the smallness of the shell.

Type. *Spirolinites cylindracea* †.

Shell straight, curved at the apex only; aperture orbicular. Fossil, Grignon. Pl. vi. Fig. 215. 2 Species.

3. Lituolites ‡.

Shell multilocular, partly twisted into a discoidal spiral; whorls

* *Peron's.* † *Cylindrical.* ‡ From *lituus, a crooked trumpet.*

contiguous, the last terminating in a straight line. Chambers irregular, septa transverse, simple (no siphon); the last septum pierced with from three to six holes.

Small fossil shells; the septa, which form the chambers, are at unequal distances, and inclined to one another; some species have scarcely one complete turn of the spiral.

Type. *Lituolites nautiloidea* *.

Shell discoidal, caudate, ribbed; last septum with six or fewer foramina. Fossil, Meudon. Pl. vi. Fig. 216. 2 Species.

3rd Family.

Cristata. (3 Genera.)

Shell semi-discoidal; spire excentric.

The cristata, are flattened, multilocular, shells, almost reniform, or crested; the chambers gradually lengthen as they approach the exterior, arched border, and appear to turn partly round an excentric, more or less marginal, axis.

1. Renulites †.

Shell reniform, flattened, furrowed, multilocular; chambers linear, contiguous, curved round a marginal axis, those farthest from the axis, the longest.

The form of these fossil shells is very remarkable. The chambers are contiguous, unilateral, narrow, linear, curved into a portion of a circle, all disposed in one plane in such a manner that the first, or smallest, forms a little arc round a marginal axis, or centre; all the other chambers are placed on the same side as the first, whence there results a flat, reniform, furrowed shell, having its axis situated on the margin opposite to the convex part of the chambers.

One species. *Renulites opercularis* ‡.

Shell semilunar, very flat; furrows arched, concentric. Fossil, Grignon. Pl. vi. Fig. 217.

2. Cristellaria §.

Shell semi-discoidal, multilocular; whorls contiguous, simple,

* *Nautilus-like.* † From *Ren, the kidney.*

‡ *Opercular*, i. e., *resembling an operculum.*

§ From *crista, a crest*, or *tuft.*

progressively increasing in size. Spire excentric, sublateral. Septa imperforate.

Most of the cristellariæ, are flattened, crest-shaped shells, their septa are visible externally; the chambers are elongated, subradiated, of the whole breadth of the whorl which contains them, and have an excentric, almost lateral axis.

Type. *Cristellaria squammula* *.

No further description. Pl. vi. Fig. 218. 9 Species, all recent.

3. Orbiculina †.

Shell subdiscoidal, multilocular: whorls contiguous and compound; spire excentric; chambers short, very numerous; septa imperforate.

The chambers of the orbiculina seem to be of two kinds, they traverse each other, and render the whorls, as it were, compound. Most of the species of this genus are flattened, or compressed. The aperture is narrow, in the form of an arched, transverse fissure, and appears common to the chambers of the last row.

Type. *Orbiculina numismalis* ‡.

No further description. Pl. vi. Fig. 219. 3 Species, all recent.

[To be concluded.]

Art. VII. *On an Arenaceo-calcareous Substance found near Delvine in Perthshire. By* J. Mac Culloch, M.D,. F.R.S.

The present notice relates to a substance hitherto undescribed; still limited, as far as I know, to the spot named in the title, and possessing some resemblance to an object well known to mineralogists, the arenaceo-calcareous spar of Fontainebleau.

The present course of the Tay through the plain of Stormount is accompanied by high terraces of rolled stones, gravel, and sand, the ruins of the mountains from which it traces its many-headed origin, and the remains of an alluvial plain, through which it is still deepening its way, leaving these deserted records of its corrosive power.

* From *squama, a scale.* † From *orbiculus, a little orb.*

‡ From *numisma, a piece of money.*

These terraces stand at various altitudes above the present bed of the river; according to the different periods of time at which the water, once effecting its descent to a lower stage, abandoned the surface on which it had last flowed. At the point here to be described, they appear to reach to about sixty feet.

At this place, as in most others, they present an aggregation of rolled pebbles of various sizes, accompanied by a few angular fragments, which seem to have undergone a less distant transportation, and succeeded by coarse gravel and siliceous sand; the larger materials being, as usual, predominant towards the bottom, and the smaller at the top. As the river is at present impelled against the foot of this bank, it exhibits a recent section resulting from the constant waste it experiences; the surface of the declivity being frequently renewed by the losses which the mass undergoes from the occasionally increased state of the stream.

The upper and flat surface of this bank is an extensive and cultivated plain, nor is any rock to be seen for a considerable space; the alluvial soil covering the subjacent strata in most places to the depth already described, and the river not having as yet reached them any where in the immediate vicinity of the spot in question.

The fundamental rock, thus far below the site of the present appearance, is the red sandstone which succeeds the primary country of the Highlands at Birnam, and extends, with the exception of trap and its congenerous rocks only, far to the southward. There is no appearance of limestone in the vicinity, nor are any fragments of this substance obvious among the transported materials, although there is little reason to doubt that such exist in the soil.

In examining the sandy bank, thin and indurated laminæ are seen interposed among the loose materials, protruding to a small distance, and, in consequence of their superior tenacity, resisting the action of the stream and that of their own weight. On divesting them of the loose sand in which they are enveloped, they are found to present a great variety of stalactitic forms, generally more or less complicated, and often exceedingly intricate and strange. The two simplest modifications that occur, may be con-

sidered as the elements of all these capricious appearances; the one consisting of a conical concretion, and the other of a lenticular one, analogous to the stalactite and stalagmite of mineralogists. These, combined and modified in different ways, produce the several varieties of form that are found in this place.

These concretions are formed of carbonate of lime, containing sand united by that cement, in the same manner as it occurs in the Fontainebleau spar. It appears difficult at first sight to account for the stalactitic shape, since these concretions are neither formed in cavities nor in a perpendicular position. They lie, on the contrary, in a direction but little inclined to the horizon, and are generated in the' midst of the sandy stratum. It seems equally difficult to account for the presence of the carbonate of lime; but it is natural to suppose that water saturated with that substance finds its way through fissures or intervals in different parts of the bank; although it is not easy to conjecture whence it originates. It would naturally be imagined that the calcareous solution thus trickling through the sand, should diffuse and lose itself so as to form with it a loose admixture; or else thus consolidate the parts within its reach into a calcareous sandstone. But it is not unlikely that this partial formation is determined, in some measure, by the innumerable surfaces of the sand, already perhaps containing calcareous particles, and offering bases on which the earth in the solution is quickly deposited by a species of crystallization, thus checking that diffusion. The rudiment of a stalactite, once formed, serves perhaps as a conductor to the fluid, which is thus, by a continuation of the same process, enabled to prolong these concretions, in some cases, even to the length of three feet. This explanation, however, does not apply to the lenticular stalagmite and its modifications; nor am I at present able to explain how this appearance, which, in ordinary cases, results from the diffusion of successive drops falling on an exposed surface, should here occur in a close mass of sand. I must add that there is no apparent difference in the position of the two modifications; both being found confusedly together, and without that mutual relation which occurs in the common concretions of this nature: and I

may also add that the purer forms are as accurate as those found in caverns: the stalactite being a perfect prolonged cone, and the stalagmite a thin and round flat cake.

The fractured surface of the specimens varies; evidently in consequence of the greater or less quantity of sand entering into the composition, and of variations in the fineness of its particles. It is rarely so distinctly laminar as even those specimens of Fontainebleau spar which are most charged with sand; and, in general, it is so much like an ordinary sandstone that the presence of the calcareous ingredient would not be suspected. As such indeed it was originally sent to me, being supposed a corroded specimen of sandstone, of which an internal structure was detected by the usual causes of wasting.

It is perhaps of little use to state the relative proportions of the ingredients, which are moreover subject to variations; but the average of the specimens I examined gave 60 parts of sand in 100 of the stalactite.

Considering the crystalline arrangement of the carbonate of lime, as indicated by the platy fracture of the specimens, and the analogous circumstances under which the mineral of Fontainebleau is found, it might have been expected that geometric forms should also be found with the rest in the sand banks of this spot. None such have, however, yet been discovered; and the resemblance remains confined to the composition and internal structure. The present appearance can therefore only be considered as an analogy; an instance of the possibility, as that is of the actual existence, of a compounded crystal, in which the presence of a foreign body does not impede the crystalline tendency of the crystallizable ingredient, although the latter is so much inferior in quantity to the intruding material. It is probable that with a general resemblance in both cases, namely, the presence of a calcareous solution in a mass of sand, there is an essential difference, in one particular, between the circumstances under which the crystal of Fontainebleau and the stalactite of Delvine are formed. From general principles, we should conclude, that, in the former, the mixture of the sand and the solution was preserved in a constant semifluid state, fresh

calcareous matter succeeding as the first was deposited, so as to permit a slow arrangement of the carbonate of lime; while, in the latter, we are certain that the precipitation of this salt is hurried by the rapid flow and absorption of the percolating fluid. In the ordinary stalactite of caverns, the same effect results from the rapid evaporation of the water, and from the mechanical descent of that part of the solution which has not had time to deposit its contents in its passage downward. This opinion is supported by the situation in which the Fontainebleau crystal is found, namely, the fissures of a sandstone; in which it is easy to conceive that state of things which I have here suggested. The occasional variations that occur in this substance still farther confirm this view. Mineralogists will immediately perceive that I allude to that case in which the crystal consists partly of an arenaceous and partly of a pure carbonate of lime. Here, it is probable, that the fluid has so far prevailed in the fissure as to overtop the sandy mixture, thus admitting the continuation of the arrangement from the mixed to the pure part of the solution. It is probable that there would not be much difficulty in putting this suggestion to the test of experiment; by filling with sand those pools in the Spar Cave of Sky, in which, as I have shewn in another place, (Western Islands,) the formation of calcareous spar takes place.

The appearances now described will serve to illustrate another circumstance occurring, not very unfrequently, in sand, in different parts of England. The substances in question are found, among other places, in the sand that lies above the fossil bones of Norfolk; and they have been ranked, improperly, with organic remains.—They consist of long cylinders, or tubes, of different dimensions, sometimes formed of one crust or layer, at others of more; in which latter cases partial cavities sometimes occur between the layers. On analysis, they will be found, like the stalactites of Delvine, to be composed of sand agglutinated by carbonate of lime, or rather they must be considered as calcareous stalactites entangling sand. The calcareous ingredient is often, however, distinctly visible in these; forming a lamina among the successive coats, in which the crystalline particles are seen radiating from

the centre of the cylinder or tube. The same explanation evidently applies to these, as to the stalactites of Delvine. With respect to the central cavity, it is analogous to that which so often occurs in ordinary calcareous stalactites, and presents no further difficulties.

I may add respecting these, that as the sand is generally ferruginous, they are commonly of a brown colour and much charged with the rust of iron.

ART. VIII. *On the Process of Reproduction of the Members of the Aquatic Salamander. By* Tweedy John Todd, M.D., F.R.M.S.E., *&c.*

SECTION 1st. *Description of the Process in general.*

THE reproduction of the members of the Aquatic Salamander may, perhaps, be better understood by considering it as consisting of three distinct subordinate processes, *viz.*, of growth, organization, and increase. That of growth may be described as the production of a homogeneous substance, of the nature of coagulable lymph, of the form, but of a much smaller size, than the original member; that of organization, as the conversion of this substance into the different structures, which naturally constitute the member; and that of increase, as its slow and gradual progress to the size of the original part.

When the limbs of the salamander are removed, the phenomena of inflammation and its terminations present themselves as in all the other vertebral animals; nor until the cicatrix is completely formed can any difference be observed in either case, except that the extremity of the stump, which in other animals tapers and assumes a conical form, in this becomes enlarged and bulbous. This swelling of the stump generally precedes the formation of the cicatrix. It, however, sometimes coincides with it, and very rarely follows it. I have observed, when the cicatrization is protracted, the swelling of the stump precedes the cicatrix a considerable time, as much as fourteen days, and, when it is accelerated, they generally take place together. In some rare cases the tumefaction

of the stump continues after the growth has been nearly finished. Except this appearance, which I have been led to regard as a sure indication of future reproduction, no sign of it is ever to be observed until after the perfect healing of the wound; and any cause, accidental or intentional, which obstructs it, impedes also the production of the new member.

This bulbous form of the stump is proved by dissection to arise entirely from nicknamed vascularity.

A short time after the cicatrix is formed, varying from one day to six, a red projecting point is observed on its central part from which the cuticle seems to have been absorbed. This point is soft, and bleeds on being pressed. Its surface is moist and glistening, secretes a glutinous fluid, which adheres to the fingers on being touched. It is surrounded by a groove formed by the cuticle of the cicatrix being elevated above the level of its bone, in the form of a collar. The microscope discovers this spot to be a reticulated cluster of red vessels, which have protruded through the cicatrix. I have sometimes doubted whether there was a real protrusion, or whether a point of the cicatrix presented that appearance, but the constant observation of the collar-like elevation does not warrant any such doubt. In two or three days more, generally about six from the period of cicatrization, this red spot becomes a conoid protuberance, the base of which is of a transparent grey colour, but the point is still covered with the red vascular spot. Examination shews this cone to be composed of a transparent grey homogeneous matter, soft and semi-consistent, resembling coagulable lymph, or animal gluten, covered with a thin filmy membrane. This cone continues to elongate, and the red point gradually disappears sooner or later, according to the extent of the joint which is first to be restored. The usual time is about twelve days from the period o fcicatrization, when the new growth is generally about a line and a half in length. But if a very small part of the joint has been amputated, the red spot disappears much earlier, and the elevation of the new growth is hardly perceptible, for this and the stump together bear always a constant ratio to the length of the original joint, generally as two to three,

so that if little more than one-third has been removed, there is no more new growth than what is sufficient to complete the ratio.

When the growth of the first joint is completed, the vascular spot entirely disappears. The new growth at this period is irregularly conical in form, and presents all the other appearances just described. Its base is circumscribed by a red border, indicating the seat of numerous red vessels. The extreme point seems almost devoid of cuticle, or covering, but that of the base approaches, in some degree, the natural skin.

During two or three days more, generally about fifteen from the period of cicatrization, the new growth ceases to increase in length, but seems to acquire more consistence, gradually beginning to be converted into the different structures of the limb. The extremity is less pointed, and rather enlarged and bulbous. Its point is flat, and the circumference rises above the central part, which is not shining and moist, uncovered by membrane, and studded with vascular spots, which bleed on being touched, like the granulations of a wound, to which they may in many respects be properly compared. This is the commencement of the growth of the second joint of the extremity, and is an exact repetition of the process observed in the growth of the first.

The new growth, however, does not shoot forward in the line of the axis of the first joint, but forms an obtuse angle with it.

The growth of this joint generally occupies about seven days, and is finished about the twenty-first after cicatrization, at which time the new extremity has acquired about four lines in length, always, however, depending on the length of the original limb.

At this time also the site of the angle is observed to form a narrow neck-like depression, the incipient formation of the second articulation.

The new growth of the second joint is less round and more flat than that of the first, and it bears a less proportion to the size of the second joint than the new growth of the first does to its original. It is seldom a line in length.

About this period the point of the new growth is observed to be flattened and a vascular line is seen upon it, from which soon

arises a flattened conoid projection, the rudiment of the foot. This last growth occupies about three days, and seldom exceeds half a line in length, this bearing still less proportion to the part of the original member which it represents.

A day or two after the growth of the foot is completed, and when the stump and new growth together are equal in length to the original first joint, two vascular spots are observed in the extremity of the new member, from which two knobs, the rudiments of the phalanges of the second and third toes, soon push forward. In a day or two more appear in the same manner, in succession, those of the first, fourth, and fifth, according as it may be the anterior or posterior extremity. This process is repeated at certain intervals, until the growth of all the phalanges is terminated, but of the same diminutive size as the other parts of the new extremity. This seldom occurs before the fiftieth day from the date of the cicatrix.

About the sixtieth day the whole length of the new growth and stump together is equal to only half of the original limb, the stump and new growth of the first joint being about two-thirds the length of the original one, the leg about three-fifths, the foot about one-third, and the toes about one-sixth, the diameter of the leg about one-half that of the original one, and the breadth of the foot about one-third.

Whilst the growth of the lower joints is taking place, the process of organization is going on in the superior ones, so that when the growth of the second joint is completed, the first has acquired a certain degree of firmness to give it support. About forty days from the period of cicatrization, we find more than two-thirds of the first joint occupied by a solid and central part. This central part is an elastic substance, resembling cartilage in appearance. It is transparent, except in some points towards the superior end where a cloudy white deposit is observable. Surrounding this some fibrous structure like muscular is to be seen, and the remainder, except the cutis, which is nearly organized at an earlier period, about the forty-third day, is of a soft gelatinous nature. In the new growth neither the trunks of the blood-vessels nor the

nerves can be discovered, although the minute ramifications of both are visible.

About the fiftieth day dissection shews that the trunk of the original nerve terminates abruptly at the new growth, and branches of fibrous matter appear to radiate from its extremity, which is considerably swollen and expanded. It appears as it were a new growth. The limb is striated with red vessels, presenting the appearance of a tortuous congeries in the course of the original trunks. The original muscles seem continued by new ones into the new structure, and the new limb is already used in locomotion. Though the external form of the articulation seems natural, its internal structure cannot be accurately distinguished. Beneath the first articulation, the new growth, with the exception of its coming, consists almost entirely of a homogeneous glutinous substance.

About sixty days from the period of cicatrization, the first and second joints are perfectly organized, although the new growths of the toes continue soft and glutinous. At this period also all the partial motions of the first and second joints are observed. The old and new bones are united together by callous, resembling the union of a fracture. Even at this period the trunk of the nerve does not extend into the new member, but terminates at its commencement.

The process of organization proceeds in the other joints in succession, but is not completed in all before the hundredth day.

The process of increase is much slower than that of the two preceding ones. It commences in every one as soon as their organization is finished, but the period in which it is itself completed is so indefinite, depending so much on the season of the year, it is difficult to assign it any particular term. It, however, seldom takes place at any time within less than a year.

The reproduction of the tail, though appearing to differ from, follows the same process of growth as that of the limbs. As in that case no growth takes place until after cicatrization, and it is preceded by the vascular structure, only of a different form. The

bulbous enlargement of the stump is, however, certainly much less sensible.

After cicatrization, which is often very tedious, arising from the exfoliation of the vertebræ, the new growth makes its appearance, preceded by a longitudinal vascular spot. The new growth is a flat triangular projection, the base of which is less than the breadth of the stump. It is perfectly soft and flexible, and of a transparent colour, except at its edges, which are striated with red vessels.

Although the growth takes place as well from the sides as the apex of the triangle, its increase in breadth does not keep pace with its increase in length. Thus, when it has acquired four lines, the base of the new production is only about five-sixths the breadth of the stump, presenting the form of an isosceles triangle, a miniature of the original tail.

As soon as the new growth of the tail, which takes place much more rapidly than that of the limbs, is about four lines in length, a triangular opacity is observed, projecting into it from the stump. This is the rudiments of the spine, which, together with the formation of the cutis, is the beginning of the process of organization.

The new growth of the tail bears a much greater proportion to the original size than the new growth of the limbs. The process of organization is much sooner completed, and that of increase requires a much shorter period. In the course of two months from the period of cicatrization, the new tail can with difficulty be distinguished from the original one.

The processes of reproduction in the larva of the salamander, are exactly the same as in the perfect animal, except that they commence sooner, and are sooner completed.

Section 2d. *Variations of the Process, &c.*

It is a most difficult task, and, I may almost say, a fruitless one, to endeavour to induce any derangement in the process of reproduction. It is, however, a pleasing one to observe the new means by which nature is ever prepared to adapt herself to every new circumstance and exigency,

If, instead of a straight line, the amputation be made in an oblique one, the new growth instead of commencing in one point and one projection, commences at the same moment in two separate ones. But the growth of the superior, or proximal, one, goes on in a ratio so much greater than the other, it soon overtakes it, thus speedily correcting the obliquity. These separate growths united together at their bases, soon form one, and the process of reproduction is continued in the usual manner. It is worthy of remark, that when this occurs in the reproduction of the tail, the new growth does not assume its pointed triangular form, until the two separate growths are united together.

When instead of a simple obliquity, the amputation is made so as to leave a bifurcated stump, which is easily done in amputation of the tail, the new growth does not arise from the sides of the fork, but from its angle, in the form of a triangular projection, which is gradually united to them.

When, however, the method of amputation is reversed, and the stump is spear-shaped, separate growths take place from each side of the point; and, as soon as they are on a level with each other, the process proceeds in the usual manner.

It would seem that the reproduction of any of the members may be repeated, *ad infinitum;* for, as far as I have observed, I have never known any limit to it. Whether the second amputation be made during the process of growth, organization, or increase, the secondary reproductions observe the same laws as the primary one, except that the nearer the amputation is made to the period of growth, when the structure is most simple, the cicatrization is quicker, and the growth takes place in a shorter period.

The process of reproduction is much influenced by the season of the year. In the months of April, May, and June, it is comparatively slow in its progress. It proceeds with the greatest rapidity in the month of August, the period of greatest general vigour.

The reproduction does not appear in any way materially affected by the animal being in spawn, nor does the privation of food, which these animals are able to support for a considerable time, in any sensible way interfere with the process.

It would seem, also, that whether one or all the members are to be reproduced at the same time, the process goes on with equal rapidity.

It was natural to inquire whether reproduction was a property possessed generally by the other parts of this animal, or whether it was strictly confined to those members in which it has been described. The results of my researches only warrant me in stating, that this power is possessed by the extremities, the tail, the lower jaw, and the crest of the male. I have looked for it in vain in the eyes, although I have watched the changes in the part for a very considerable time after cicatrization. I have never observed it in any of the internal organs; nor have I been satisfied that it takes place in the bronchiæ of the young animal. When any other parts of the body, except those capable of reproduction, are removed, the healing process proceeds as in other animals, leaving a cicatrice, unequal and depressed, which is never obliterated.

It was also an object of my researches to discover whether reproduction commenced in any particular structure in preference to the others. To these inquiries I have always received a negative answer, leading me to conclude, that the reproducing vessels are contributed by all the structures. This, however, was not the case when the inquiry was pursued conversely, so as to determine the influence of the arterial and nervous system on the growth of the new production. As relates to the former, my observations were less conclusive and satisfactory, but concerning the latter, perfectly conclusive.

If the sciatic nerve be intersected at the time of amputation, that part of the stump below the section of the nerve mortifies, reproduction following the cicatrix in the usual manner. If the division of the nerve be made after the healing of the stump, reproduction is either retarded or entirely prevented. And if the nerve be divided after reproduction has commenced, or considerably advanced, the new growth either remains stationary, or it wastes, becomes shrivelled and shapeless, or entirely disappears. This derangement cannot, in my opinion, be fairly attributed to the vascular derangement induced in the limb by the wound of the divi-

sion, but must arise from something peculiar in the influence of the nerve. I must, however, observe the same uniform influence was not observed in every part. The intersection of the spinal marrow at the origin of the tail had no power of checking its reproduction.

SECTION 3d. *Comparison of the Process of Reproduction in different Animals possessing this power.*

In reasoning on the phenomena of reproduction, the comparison of this process, in the different animals endued with it, naturally presents itself to the mind as a method by which further knowledge of the process may be obtained.

In the tadpoles of the frog and toad the process is precisely the same as in the lava of the salamander. But except in the reproduction of the tail, which is both constant and vigorous, it is very uncertain in its extent, and strictly confined to certain states of developement, the absorption of the tail distinctly marking the period when the power is entirely lost. It is, however, curious to observe to how near the moment of metamorphosis the reproduction of the tail continues.

I have ascertained that the reproduction of the tail of the lizard is effected by the same process as that of the salamander, and, I should think, from what may be collected from Reaumur's observations, it is probably the same in the crayfish and its species. In the snail I have also every reason to believe the same process is observed.

From the very interesting experiments of my ingenious friend, Professor San Giovani, of Naples, I am authorized to conclude, that although the reproduction of the earth-worm presents some specific differences, yet the general process is the same. I am entirely indebted to his liberality for the following account of it. When earth-worms are divided at the lower edge of their great ring, if they survive the injury, which they generally do three in twenty times, the separate parts gradually diminish in circumference, the wounds cicatrize, and the cicatrix, which is of a bright red colour, is surrounded by a round projecting band, (*bourrelet,*)

In the anterior half, reproduction goes on rapidly, for in twenty-four days from the beginning of the experiment, four or six of its rings are already reproduced in all about four or five lines in length. As soon as reproduction commences, the round projecting band ceases to be observed. The new production is transparent, of a clear reddish colour, and of the same size and diameter as the rest of the body. The anus is perfectly formed, and the parts of the vessels, nerves, and alimentary canal belonging to the new growth, can be observed, as well as the lateral filaments distributed by pairs to each of the new rings. The great ring, it is worthy of remark, entirely disappears during reproduction. The process continues to proceed in the same manner, though with less rapidity, being apparently much influenced by the season of the year. Two hundred and thirteen days from the commencement of the experiment the anterior halves have each reproduced twenty-five or twenty-six rings, the new growth becoming gradually redder, less transparent, and more perfectly organized. Their diameter is every where equal, as well in the new part as the old, so that the new tail continues conical instead of being flattened as in the original.

The process of reproduction is much slower in the posterior halves. They preserve a healthy and well nourished appearance, their anterior extremity cicatrizes and tapers very much, becoming more pointed, and appearing to assume the form of a head; not, however, until fifty-five days from the beginning of the experiment can the new growth be distinctly perceived, when only three or four new rings are observed at the anterior extremity, their termination, the seat of the head assuming a pointed conical form, approaching nearer that of the natural head. Two hundred and thirteen days from the beginning of the experiment the posterior halves have each reproduced five or six rings, and the head in appearance, (for it does not appear that its real organization was determined by dissection,) only differs from the natural one in being more obtuse and less tapered.

Thus, from the division of those worms, Professor San Giovani

obtained six perfect ones, which he submitted to the inspection of the Royal Academy of Naples, in May, 1815.

We here observe, as in the salamander, the bulbous enlargement of the stump, the red vascular structure, the first growth of a transparent appearance, and its gradual transition to a more perfect structure. It is also probable, that had the observations been made more minutely, and more in relation to the process, the resemblance would have been found more exact.

The specific differences which the case affords are the diminution in diameter of the original part, and the new growth at once of the same size, as also the early organization of the alimentary canal, the nerves, and vessels.

The disappearance of the great ring, or *renflement*, the organ of copulation, is a fact both curious and interesting, although only in unison with the general economy of nature.

This general resemblance, which we find in the process in the above-mentioned animals, can, however, with no reason be expected in the polypi, whose nutrition is carried on without any vascular system. This difference of structure and functions would only make the prosecution of this comparison, through this order of animals, more useful and necessary. But whatever may be the difference of the process in the different classes of animals, it is very obvious that the power of reproduction itself, though more common in the lower animals whose structure is most simple, is not dependent on the difference of organization in the various classes, but can only be referred to some law of organization peculiar to the species possessing it. This conclusion is most forcibly illustrated in the salamander and lizard, whose power of reproduction is strictly confined to certain numbers; and in the tadpole, which loses this power immediately on arriving at its state of full developement.

Section 4th. *General Observations.*

Although the process of reproduction, as I have described it, affords matter for many important deductions, I shall content my-

self with one or two general observations. The process of growth naturally leads us to consider the more general law of organization, from whence it would seem to emanate; I mean, the formation of structures, or tissues, through the intermediate agency of that substance, which we call coagulable lymph. Indeed, it would seem that this matter is the matrix of every structure. It is the simplest form of animal existence, and it is the first state of existence of even the most perfect animals. It is the medium through which every breach of continuity is united, and through which every loss of substance is restored. And although it is only on such occasions that its existence and importance is developed to us, there is good reason to believe that it constantly exists as a separate and independent part in all animals, in a greater or less degree, and that it is through its means that the whole process of nutrition is carried on. As forming a part of animals it bears always a certain proportion to the others, being inversely as their state of perfection, and in the simplest of them as in the animalculæ of the sponge it appears to be the sole and only one.

The knowledge we possess of this substance we entirely owe to Mr. Hunter, an obligation, which, together with his views of inflammation, I hold to have as high claims on the gratitude of society as any discovery which has ever extended the power of human art over the functions of animal life.

This matter in its physical properties has been considered as a peculiar kind of animal gluten, similar in the opinion of many, and the same in the opinion of a few, as the fibrine of the blood. As regards its vital properties it is possessed of a principle of vitality, active and passive, sensible of the action of external agents, and capable of organization.

In animals of red blood it is invariably produced by the red arterial capillaries. This I hold to be an undeniable fact. In the most transparent and colourless parts, where no coloured vessels are to be seen, the secretion of coagulable lymph is preceded by an afflux of red blood, and this, after symptoms of inflammatory action had entirely ceased, or where it has never existed, as in the progress of the reproductions of the tails of tad-poles. It is,

indeed, singular, that the red vessels should be the instrument of every new production of parts, which in their natural state do not possess red vessels, and which disappear whenever the growth is completed.

Soon after this substance is formed by the capillary arteries, it is covered by a thin transparent temporary film or pellicle. The formation of this pellicle is almost simultaneous with another change, its penetration by blood vessels. I hesitate in stating this fact by a passive expression, for I regard the lymph as an active agent in the formation of the vessels. Immediately after the new growth has become vascular the process of organization commences, and the red vessels almost entirely disappear, unless when another growth is to take place where the red vascular spot is observed at the extremity as usual. May we hence conclude, that the new growths take place from the red vessels, and that organization is effected by the colourless ones?

The reproduction of the members of the salamander is so justly associated with the name of Spallanzani, who first observed and published this extraordinary fact, it may fairly excite surprise, that more present mention is not made of that observing naturalist in the preceding pages; but although desirous of confining myself strictly to my own personal observations, never having been able to procure his *prodromo*, I have been prevented availing myself of his experience and authority.

Naples, February 28, 1823.

Art. IX. PROGRESS OF FOREIGN SCIENCE.

1. *On Titanium and its Combinations with Oxygen and Sulphur, by* Henry Rose, *of Berlin.*

In the first half of his paper, Mr. Rose treats of the peroxide of titanium, (called by him, properly enough, titanic acid,) and its combinations with the alkalis and acids. We do not find here any thing very worthy of extract. After trying in vain to reduce that oxide to the metallic state by zinc, and a stream of hydrogen gas at high temperatures, he finally had recourse with happier effect to sulphuret of carbon, employed in similar circumstances.

The titanic acid should not be used in a pulverulent form, since it is impossible to separate mechanically, the resulting sulphuret of titanium from the residuary titanic acid. Hence he brought it into the state of a thick paste with water, which he squeezed strongly between folds of blotting paper under a press, so as to obtain cohering pieces, which retained their cohesion on being ignited. These lumps he put into a porcelain tube, to one end of which a retort was luted air-tight, containing rectified sulphuret of carbon. The other end of the tube terminated in a small glass tube, which was left open. After the porcelain tube had been heated red for half an hour, he applied a lamp to the retort, and the gas was kindled as it issued from the end of the glass tube, in order to shew, by the force of the flame, whether a suitable quantity of sulphuret of carbon was evaporated. As the result was more satisfactory in proportion to the slowness of the evaporation, he reduced the flame to a size scarcely visible, by removing the lamp to a considerable distance from the retort. The operation generally lasted from four to six hours, care being taken that some sulphuret of carbon should always remain in the retort. By means of a spirit lamp, he then fused the extremity of the small glass tube, and withdrew the apparatus from the fire, so that the sulphuret of titanium should be surrounded during the cooling with an atmosphere of alcohol of sulphur, a precaution essential to prevent the action of air on the ignited sulphuret, which would reconvert it into titanic acid.

Sulphuret of titanium, thus formed, has a dark green colour. The slightest rubbing with a hard body, gives it instantly a strong metallic lustre; the metallic streak is brass yellow. When heated in open vessels, it takes fire as soon as it becomes red hot, burning with a blue sulphureous flame, and is converted into titanic acid. The metal of the compound gets oxygenated sooner than the sulphur, by roasting in the air. On pouring nitric acid on the sulphuret, nitrous vapours exhale, the mixture becomes hot, and finely comminuted titanic acid falls to the bottom of the vessel. The simplest and most accurate method of analyzing this sulphuret, was by its combustion, on platinum foil over a spirit lamp. In this way, hard fragments were obtained, which on the slightest

rubbing assumed a bright metallic lustre. From such experiments he infers, the composition of the sulphuret to be,

Metallic titanium	49.17
Sulphur	50.83
	100.00

And supposing the stage of sulphuration to correspond with that of the oxidation in the titanic acid, he considers this as consisting of

Metallic titanium	66.05
Oxygen	33.95
	100.00

Mr. Rose details some experiments instituted with the view of confirming his opinion about the relative states of sulphuration and oxidation; but they do not seem conclusive. He considers the atom of titanium to weigh 7.782 referred to oxygen as unity. Gilbert, *Annalen der Physik*, No. lxxiii. p. 129.

2. *New note of* M. Cagniard de Latour, *on the Effects obtained from the simultaneous Application of Heat and Compression to certain Liquids.*

By the heat of an oil bath, some results have been obtained which seem to indicate such as would be procured by the employment of much higher temperatures. They are presented in the following Tables.

TABLE I. *Experiments made on Ether.*

Volume in the liquid state, 7 parts.	Volume in the state of vapour, 20 parts.	
Degrees of Reaumur.	Atmos. pressures.	Difference from one result to the next.
80	5.6 tenths.	Atmos.
90	7.9	2.3 tenths.
100	10.6	2.7
110	12.9	2.3
120	18.0	5.1
130	22.2	4.2
140	28.3	6.1
State of vapour 150	37.5	9.2
160	48.5	11.0
170	59.7	11.2
180	68.8	9.1
190	78.0	9.2
200	86.3	8.3
210	92.3	6.0
220	104.1	11.8
230	112.7	8.6
240	119.4	6.7
250	123.7	4.3
260	130.9	7.2

TABLE II. *Experiments made on Ether.*

Volume in the liquid state, 3½ parts.		Volume in state of vapour, or capacity of the tube, 20 parts.
Degrees of Reaumur.	Atmos. pressures.	Difference from one result to the next.
100	14.0 tenths.	Atmos.
110	17.5	3.5 tenths.
120	22.5	5.0
130	28.5	6.0
140	35.0	6.5
State of vapour 150	42.0	7.0
160	50.5	8.5
170	58.0	7.5
180	63.5	5.5
190	66.0	2.5
200	70.5	4.5
210	74.0	3.5
220	78.0	4.0
230	81.0	3.0
240	85.0	4.0
250	89.0	4.0
260	94.0	5.0

TABLE III. *Experiments with sulphuret of Carbon.*

Volume in the liquid state, 3 parts.		Volume in the state of vapour, 20 parts.
Degrees of Reaumur.	Atmos. pressures.	Difference from one result to the next.
80	4.2	Atmos.
90	5.5	1.3
100	7.9	2.4
110	10.0	2.1
120	13.0	3.0
130	16.5	3.5
140	20.2	3.7
150	24.2	4.0
160	28.8	4.6
170	33.6	4.8
180	40.2	6.6
190	47.5	7.3
200	57.2	9.7
210	66.5	9.3
State of vapour 220	77.8	11.3
230	89.2	11.4
240	98.9	9.7
250	114.3	15.4
260	129.6	15.3
265	133.5	3.9

Remarks on the Results contained in the above Tables.

In the first experiment, the ether passed into the state of vapour at 150°, and produced a pressure of 37 atmospheres.

The sulphuret of carbon, which is almost as volatile as ether, passed however into the state of vapour only at 220°, with a pressure of about 78 atmospheres, that is to say, double of the ether. This result is the more remarkable since the capacity of the tube which enclosed this liquid, was a little larger, in reference to the volume, than for the ether.

The irregularities observed in the succession of the noted pressures, depend probably on some inaccuracies which may have slipped into the experiments, notwithstanding every precaution. They have, however, no sensible influence on the main results. From the table of the first experiments on ether, we perceive that from 140° to 160°, the pressure increased by an atmosphere for each degree; that however, at a much higher temperature, namely, from 240° to 260°, the increase of pressure was only half an atmosphere for a degree; and that finally, at 260° the pressure became again stronger, a circumstance proceeding probably from the decomposition of the ether, or from some analogous change of state.

It appears from the experiments made on the sulphuret of carbon, that from 250° to 260°, the augmentation of pressure was an atmosphere and a half for each degree, and that at 265°, this increase lessened as with ether.

On comparing together the two tables concerning ether, we observe that up to 150°, the pressures in the tube with least liquid, are stronger than those of the other tube which contained the double. This difference arises undoubtedly from the primitive attraction of liquidity preserving, at these temperatures, least influence in the tube where the particles of the vapour are more diffused than in the other.

We may remark, in these tables, especially in the second of the experiments on ether, that it is in general when the liquid is in the state of vapour, that the increase of the pressures is the greatest. It soon diminishes, and seems thereafter to follow the same rate as in gases. From the same two tables, we further perceive that the total vaporization of the liquid, in the two experiments, occurred at temperatures slightly different. This circumstance would seem to demonstrate that this peculiar state always requires a very elevated temperature, nearly independent of the capacity of the tube. *Ann. de Chim. et de Phys.*, xxii. 140.

3. *On the Sulphurets resulting from the reduction of some Sulphates, by means of Charcoal. By* M. P. Berthier.

This diligent chemist confirms in this paper, the views of Berzelius, of which we formerly gave an account *, concerning the constitution of the sulphurets; namely, that they are compounds of the

* Vol. xv. p. 209.

metallic bases of the earths and alkalies, with sulphur. M. Berthier seems, however, to be unacquainted with the researches of the indefatigable Swede, for he says that his experiments have enabled him to resolve the hitherto undecided question, whether the alkalies and alkaline earths exist in the metallic state, in their sulphurets prepared in the dry way. It must be confessed that these experiments are so simple and convincing, as to excite surprise at their not having been sooner made.

Instead of mixing the sulphates and charcoal together in the state of powder, whereby after their ignition in a crucible, only impure sulphurets are obtained, M. Berthier finds that perfectly pure sulphurets may be procured, by heating the sulphates in crucibles lined with charcoal, (*creusets brasqués de charbon.*) This result is derived from the property which the sulphates possess, as well as most oxides, of being reduced by the mode of cementation, when they are kept exposed for a sufficient time, to a proper degree of heat in contact with charcoal. The reduction may always be completed in a few hours, by employing a white heat, even though several hundred grammes be operated on, provided the sulphuret be fusible. In other cases, smaller quantities must be taken, and a longer heat applied. The crucible must be filled up with charcoal powder, and closely covered with clay.

If sulphate of barytes, sulphate of strontites, or sulphate of lime perfectly pure, and previously calcined, be heated in a *brasqued* crucible, (one lined with solid charcoal,) to the temperature of an iron-ore assay, the resulting sulphuret forms a well agglomerated mass, which may be withdrawn from the crucible without breaking it, by the dexterous application of a knife blade; and by taking the weight of the sulphuret, it is found that the loss suffered by the sulphate is precisely equal to the weight representing the quantity of oxygen contained in its base and its acid. If, on the other hand, the sulphuret be dissolved in muriatic acid, we shall ascertain that during the solution, nothing but perfectly pure sulphuretted hydrogen is disengaged, and that there is formed no deposit of sulphur, nor oxygen-acid having this combustible as a base. Finally, if we heat a portion of the sulphuret in a silver crucible, along with three or four times its weight of nitre, we shall regenerate exactly the quantity of sulphate corresponding to the portion of sulphuret employed, and that the regenerated sulphate, contains no excess, either of base or of acid. These three experiments concur in proving, in the most evident manner, that the sulphurets produced from the sulphates of barytes, strontites, and lime, contain no oxygen, and consequently that their bases in the metallic state.

The sulphurets, obtained on reducing the sulphates of potash and soda by charcoal, are equally in the metallic state; for they dissolve in the acids with the disengagement of pure sulphuretted

hydrogen gas, and without a deposit of sulphur, &c.; and they are transformed into neutral sulphates by the nitrate of barytes; but it is not possible to have a proof of this fact in the proportion of oxygen which is disengaged during the reduction, as with the sulphurets of barium, &c., because the sulphurets of potassium and sodium are so fusible and volatile that the greater part penetrates into the charcoal coating, while the rest is dissipated in vapour.

We shall content ourselves with one or two examples of Mr. Berthier's experiments. 120 grammes of crystallized sulphate of barytes of Auvergne, reduced to powder, having been heated in a *brasqued* crucible at the porcelain furnace of Sèvres, afforded a mass of sulphuret strongly agglutinated, of a granular crystalline fracture, and a slightly reddish-grey colour. It weighed 86 grammes. The loss was therefore 34 grammes = 28 per cent, as in a former experiment. Now the quantity of oxygen contained in the sulphate of barytes being theoretically 28.5 *per cent.*, it is evident that the sulphuret produced by the reduction of this salt is the sulphuret of barium, B.S., which must be composed of

Barium	0.8099	100
Sulphur	0.1901	24,47

The sulphuret of barytes, thus procured, dissolves completely in water, without colouring it. Muriatic acid disengaged sulphuretted hydrogen from the solution without perceptibly disturbing it.

Compound Sulphurets.—The alkaline sulphurets, and the alkaline-earthy sulphurets unite very readily together, and with most metallic sulphurets in the dry way. Although this combination can take place nearly in every proportion, the resulting bodies are true combinations and not mere mixtures. In fact, these bodies are perfectly homogeneous, and frequently retain no trace of the physical properties of their components, or at least of one of them. These compound sulphurets are analogous to alloys, and to vitreous mixtures.

Sulphate of Potassium and Barium.—5 gr. of sulphate of potash, and 5 gr. of sulphate of barytes, afforded a button of sulphuret weighing 5.6 gr. and which consequently must have contained

Sulphuret of potassium	0.357
Sulphuret of barium	0.643

It thence follows that more than the half of the sulphuret of potassium, produced from the sulphate of potash, had been volatilized during the operation.

4. *On the acid of the triple Prussiates.* By M. Gay Lussac.

The nature of the acid contained in the combinations distinguished a short time since by the name of *triple prussiates*, as also its chemical constitution, appear to me no longer involved in uncertainty. M. Porrett, to whom we owe the important

discovery of this acid, considers it as formed of carbon, iron, azote, and hydrogen; but his experiments do not demonstrate in a satisfactory manner the absence of oxygen, since they have led him to ascribe to iron other degrees of oxidizement, besides those which had been determined by more direct means. M. Robiquet and M. Berzelius are of the same opinion with Mr. Porrett; M. Berzelius found that the precipitate, obtained, by pouring a solution of lead into the triple prussiate of potash, is formed of

	3 atoms of	cyanogen;
	2 „	lead;
	1 „	iron;
or of	2 „	cyanide of lead;
	1 „	cyanide of iron;

The triple prussiates $\left\{\begin{array}{l}\text{of potash and iron;}\\ \text{of barytes and iron;}\\ \text{of lime and iron;}\end{array}\right.$

have an analogous composition; that is to say, they contain each

1 atom of cyanide of iron.
2 atoms of the cyanide of the other metal.

Now since the hydrogen, contained in the acid of the prussiates, has totally disappeared, and since no more oxygen is found in the triple prussiates, and particularly in that of lead, which I shall take as an example, these two bodies must have united to form water; and, consequently, the acid of the triple prussiates must contain a sufficient quantity of hydrogen to neutralize the two proportions of oxygen contained in the two proportions of oxide of lead. This salt must be composed, therefore, of

	2 atoms of	hydrogen;
	1 „	iron;
	3 „	cyanogen;
or of	2 „	hydrocyanic acid;
	1 „	cyanide of iron.

I consider this acid as a true hydrogen acid, whose radical should be formed of one atom of iron, and three atoms of cyanogen.

When we combine it with an oxide, its hydrogen forms water with the oxygen of the oxide, and its radical unites with the radical of the latter. The compound is no longer a prussiate. It is a *cyanoferruret*. Reciprocally, when we decompose a cyanoferruret by a hydrogen-acid, sulphuretted hydrogen for example, the hydrogen of the latter combines with the cyanides of iron (*cyanoferre*), and produces the *hydro-cyanoferric acid*. In other respects, the theory of the cyanoferrurets, and of the hydrocyanoferrates, would be exactly the same as that of the sulphurets and the hydrosulphates, of the chlorides and hydrochlorides, &c.

It is undoubtedly premature to give a name, such as *cyanoferre*, to a being still hypothetical, or at least which has not been obtained insulated; but on one hand, I regard its existence as very

probable, and on the other, the denomination which I have employed expresses clearly my notions of the nature of the triple prussiates.—*Ann. de Chim. et Phys.* xxii. 320.

5. *Note on the Purpuric Acid, by* M. J. L. Lassaigne.

M. Vauquelin in repeating the experiments of Dr. Prout and M. Gaspard Brugnatelli, on the peculiar acid which is formed, by the mutual action of nitric and uric acids, obtained results different from those announced by these two chemists. He observed that two acids were usually produced, viz., a coloured acid, and a white acid of great power. These two acids are essentially different; the first is coloured, and forms an insoluble salt with lead; the second is white, and affords a soluble salt with the oxide of the same metal. Neither of these acids, exhibited the properties detailed in the Memoirs of MM. Prout and Brugnatelli; a circumstance which he ascribes to these chemists not having obtained it in a state of purity.

Although M. Vauquelin did recognise the formation of two distinct acids in the above process, their real existence appeared to him somewhat doubtful. He thinks there may be truly but one, whose properties might be modified by a colouring matter developed at the same time. He supports this opinion by plausible considerations. M. Lassaigne subjected to the action of voltaic electricity a weak solution of coloured purpurate of ammonia in a glass tube, connected by threads of amianthus with another, containing distilled water. He obtained at the end of some hours, a colourless acid at the positive pole, which, when combined with ammonia, produced a colourless salt, exhibiting all the characters of the white salt obtained by M. Vauquelin, and not precipitating the solutions of lead and silver, as happened before the transfer of the pure acid to the positive pole. M. Lassaigne considers this experiment as decisive of the justness of M. Vauquelin's views, and of the impurity of the substance operated upon by Dr. Prout. The name purpuric acid, he accordingly proposes to change into *superoxygenated uric acid.* May not this superoxygenation, which destroys the colour, be acquired at the positive voltaic pole?—*Ann. de Chim. et de Phys.* xxii. 334.

6. *New mode of forming Cyanic Acid. By* F. Wöhler *of Hiedelberg.*

The researches of M. Gay Lussac shewed that the proportion of carbon to azote in uric acid, is the same as in cyanogen; and it is known that during the igneous decomposition of uric acid, some prussic acid is produced. M. Wöhler prepared a large quantity of urate of mercury, by mixing a solution of corrosive sublimate, with a hot solution of the sparingly soluble urate of potash, prepared in M. Braconnot's way. He then exposed the

urate of mercury to a decomposing heat, and transmitted the strong smelling gas that was disengaged, into barytes water. The cyanate of barytes, the salt of this class, with which he was best acquainted, is the one most easily separable from impure prussic acid. Much carbonate of barytes fell down, and at the same time, a soluble prussiate of barytes was formed. The latter was decomposed by a current of carbonic acid gas; after which the whole was heated, filtered, and evaporated. In this way he obtained a perfectly white salt, in little scales, whose base was barytes, and which being dissolved in acids, evolved a substance of a vinegar odour, which excited a flow of tears, along with much carbonic acid, and then ammonia by the addition of potash. It exhibited in fact all the properties of cyanate of barytes, as described by him in a former number of the Annals.

Urate of mercury appears to yield a greater proportion of cyanic acid, than an equal quantity of cyanide of mercury.

When cyanogen is transmitted over heated carbonate of potash, this becomes speedily fluid, then gradually yellow, and on cooling it concretes into a bright yellow mass, which consists of cyanide of potassium, mixed with carbonate and cyanate of potash. The last salt is separable from the other two combinations, by boiling alkohol.

The following process answers best for preparing cyanate of potash. Four parts of finely powdered cyanide of potash and iron, intimately mixed with three parts of nitre, are to be gradually projected into a crucible at dull ignition. At each addition a white vapour arises which attaches itself to cool bodies, and consists chiefly of cyanate of potash. The mass, still in a semi-fluid state, is to be taken out of the crucible, to be pulverized when it cools, and boiled in ordinary alkohol, which is to be poured off, and allowed to cool. Cyanate of potash now crystallizes in small plates. By re-dissolution in hot alkohol, crystallization, and pressure (between folds of porous paper) the salt may be obtained perfectly pure. About 20 parts of cyanate of potash may thus be obtained from 100 of the triple prussiate. The plates of the cyanate have a great resemblance to chlorate of potash. It is not altered in the air. Its taste is very similar to that of saltpetre. It is slightly soluble in cold alkohol; but very much so in water. When heated it melts even at a temperature far under a red heat, into a fluid as limpid as water, and is not decomposed even when long kept in a state of ignition; but if a drop of water be then dropped into it, an extraordinary quantity of ammoniacal gas is immediately exhaled. Treated with sulphuric acid, it is rapidly decomposed into carbonic acid, sulphate of potash, and sulphate of ammonia, which last is easily discoverable by the addition of potash. With dilute acids, it exhales carbonic and cyanic acids, and an ammoniacal salt is formed. When the solution of cyanate

of potash is heated to the boiling point, a great deal of ammonia is disengaged, and carbonate of potash remains dissolved.

Cyanate of silver is obtained in the form of a white powder, by precipitating a solution of nitrate of silver, with cyanate of potash. This salt of silver, treated with acids, evolves carbonic and cyanic acids, and an ammoniacal salt is generated. It is very soluble in aqueous ammonia, by the evaporation of which, large semitransparent crystalline plates are formed, resembling quickly crystallized hydrate of barytes. These constitute cyanate of silver and ammonia.—A cyanate of lead is obtained in the form of a thick white precipitate by mixing solution of acetate of lead, with one of cyanate of potash. It appears in small needles, like muriate of lead, and is like it soluble in hot water. It is composed in 100 parts of 75 oxide of lead, and 25 cyanic acid. From the igneous analysis of this salt, M. Wöhler infers the composition of the acid to be,—

Carbon	31.664
Azote	36.940
Oxygen	31.396
	100.000

From theoretical considerations he offers the following modified statement of these proportions as probably more correct.

Carbon	2 atoms	35.294
Azote	1 „	41.177
Oxygen	1 „	23.529
		100.000

As the atomic weight of the acid thus becomes 4.25, its compound with oxide of lead $=14$, should give per cent. 76.713 oxide to 23.287 acid, instead of 75 and 15, as by the above experimental result.—Gilbert's *Annalen*, lxxiii, 157.

7. *On Felspar, Albite, Labradore, and Anorthite. By* Gustavus Rose, *of Berlin.*

Some differences which Mr. Rose observed in the angles of certain crystals, hitherto classed among the felspars, led him to make a closer investigation of them; the result of which was, that under these crystals are contained four species, differing both in a crystallographical and chemical point of view, though in the former respect they exhibit an undoubted analogy.

Felspar proper, $KS^3 + 3\,AS^3$, is the most abundant of these species. To it belong the Adularia of St. Gothard, the glassy felspat of Vesuvius and the Siebengebirge, the Amazon-stone of Siberia, the Labradore-felspar from Friedrichswärn in Norway, the felspar of Baveno, Carlsbad, and the Fichtelgebirge, and generally most part of Werner's common felspars.*

The second species, Albite, is more rare. It is denoted by $NS^3 + 3\,AS^3$. Eggerts first found it in an uncrystallized fibrous and granular form at Finnbo and Broddbo, near Fahlun, and thereafter Haussmann and Stromeyer in a mineral from Chesterfield, in North America, to which the former gave the name of Kiefelspath. Nordenskiold found it in a granite at Kimite, near Pargas, in Finland; and Ficinus in a granite from Penig, in Saxony. All these are uncrystallized varieties. To the crystallized, which I have had occasion to see, belong the white schorl, first described by Romé de l'Isle; the felspar crystals of Dauphiny of Häuy; the small crystals from Saltzburg and the Tyrol, known a few years ago under the name of Adularia.

The third species forms the Labradore spar, which Klaproth analyzed and distinguished from felspar, though mineralogists did not consider it as a distinct species. Berzelius has assigned to it the formula $NS^3 + 3\,CS^3 + 12\,AS$ from Klaproth's analysis.

The fourth species is the rarest of the whole. Mr. Rose has recognised it only in the druses of limestone blocks, which are found at Mount Somma, near Vesuvius, where it occurs in small shining perfect crystals. He has determined its formula to be $MS + 2\,CS + 8\,AS$; and has called it Anorthite.

Albite is readily distinguishable by the twin grouping of its crystals. Its primitive form is an irregular parallelopiped. In its massive state, it differs from felspar, in not being straight foliated, but always radiated. Labradore spar is completely decomposed by concentrated muriatic acid, while felspar and albite are not affected by it. Anorthite yields to muriatic acid as Labradore-spar does. The name is derived from ἀνοϱθος, not rectangled; as the want of a right-angled cleavage, in both directions of its laminæ, peculiarly distinguishes it from felspar. We must refer to the paper itself for the details of the Crystallization-system of the above minerals.—Gilbert's *Annalen*, No. lxxiii. p. 173.

8. *On the influence of Tartaric Acid in certain cases of Analysis. By* Mr. Henry Rose, *of Berlin.*

In the first part of Mr. Rose's Memoir on Titanic Acid, (or Oxide,) we find the following method prescribed as the most convenient for obtaining it pure; to which a note is appended relative to the influence of tartaric acid in analysis.

The rutile of St. Yrieux, in the department of Upper Vienne, in France, was the titanium-ore employed. He fused the rutile with thrice its weight of carbonate of potash, washed the fused mass with water, dissolved the residuary combination of titanium oxide and alkali in muriatic acid, and threw down the oxide from this solution by ammonia. The flocculent precipitate contained as much iron as the rutile itself, and this iron is chemically united with the oxide of titanium, for muriatic acid does not abstract it.

He then transferred the precipitate into a phial along with hydro-sulphuret of ammonia, corked it up, and left the substances for some time in digestion. The iron was thereby converted into a sulphuret, which was removed by digestion in muriatic acid, while the greater part of the oxide of titanium remained in a pure state. Oxide of titanium thus prepared has a fine white colour. When ignited, it assumes a lemon-yellow hue, which on cooling passes back into white. If this ignited oxide be laid on blue litmus paper, and moistened with water, the water becomes reddish, but the paper remains unchanged. But when finely triturated oxide is sprinkled on tincture of litmus covering white paper, the liquid is immediately reddened. It combines with alkalis, forming salts, which are for the most part with excess of acid. The super-titanate of soda is composed as follows:

Titanic acid . . .	74.73
Water	10.13
Soda	15.14
	100.00

The dry salt consists of about 83 parts of acid and 17 of soda in 100.

When a solution of red oxide of iron in an acid is mixed with tartaric acid, it is known that the oxide can be precipitated neither by caustic alkalis, nor by their carbonates or succinates; but tincture of galls, triple prussiate of potash, and alkaline hydrosulphurets, shew the presence of iron in such a solution. Mr. Rose hence conceived, that if the muriatic solution of the titanium-oxide fused with alkali, were mixed with tartaric acid, he might obtain, by precipitation with ammonia, that oxide entirely free from iron. But he found that tartaric acid imparted to the solutions of many other oxides, the property "of not being thrown down by caustic alkalis or their carbonates, though they were otherwise precipitable by them. Among these oxides, that of titanium ranks; for when its solution contains tartaric acid, it cannot be thrown down by carbonate of potash, or by carbonated or pure ammonia. The presence of alumina in a solution cannot be detected by re-agents, when this contains tartaric acid, which in like manner prevents the coloured aluminous lakes from being precipitated. Moreover, the oxides of manganese, of cerium, yttrium, cobalt, nickel, and magnesium, are in the same predicament. Solution of proto-sulphate of iron with tartaric acid is merely rendered intensely green by ammonia, and changes, after long standing in the air, to a yellow-coloured solution which contains iron. The oxide of lead likewise is not separable by alkalis, when its solution has been treated with so much nitric acid, that no tartrate of lead can precipitate. Oxides of tin and copper fall under the same head. The solution of the latter mixed with tartaric acid becomes, on the addition of carbonate of potash, merely of the same sky-blue

colour, which excess of ammonia occasions. Lastly, the oxide of antimony, when its solution in an acid is mixed with the tartaric, resists both alkalis, and the most copious dilution with water. In this way oxide of bismuth may be separated from oxide of antimony; for the former is still precipitable though dissolved in company with tartaric acid. The muriate of platinum is not altered in this respect by tartaric acid; nor are the oxides of silver, zinc, and uranium. Phosphoric and arsenic acids alone shew some analogy in these properties to tartaric acid.—Gilbert's *Annalen*, lxxiii. p. 74.

9. *On the existence of Carbonate of Magnesia in the Urinary Calculi of Herbivorous Animals. By* Mr. J. L. Lassaigne.

MM. Wurzer, J. F. John, Stromeyer, and Chevreul, had noticed this as a constituent of these concretions, in the horse and the cow. M. Lassaigne examined the collection of these calculi in the cabinet of the Royal School of Alfort. He treated them with sulphuric acid, calcined the saline mass thus obtained, which is principally sulphate of lime, washed it with 3 or 4 times its weight of cold water, precipitated the aqueous solution with bi-carbonate of potash, filtered the liquor, and then exposed it to the action of heat, when he observed the presence of magnesia. Its quantity is indeed small, not exceeding one hundredth and a half, or two hundredths of the weight of the calculus; but he conceives, however, that carbonate of magnesia always accompanies the carbonate of lime in such cases.—*Ann. de Chim.* xxii. 440.

10. *New Process for extracting Elaïne from Oils. By* M. Peclet.

This process is founded on the property which stearine possesses, of saponifying in the cold with strong leys, which does not belong to elaïne. To separate these two substances, a concentrated solution of caustic soda is to be poured upon the oil, the mixture is to be agitated, and gently heated, so as to separate the elaïne from the soap of the stearine; after which it is to be passed through a linen cloth, and the elaïne may be removed from the excess of alkaline solution by decantation. The process always succeeded with all oils, except the rancid ones, or such as had been altered by the heat. The elaïne, obtained by this process, is perfectly identical with that procured by the processes of MM. Chevreul and Robiquet.

11. *Memoir on the Causes of the Diversities found in Soaps, in reference to their hardness and smell; and on a new group of Organic Acids. By* M. Chevreul.

Hard soaps lose the greater part of their *water of fabrication* on exposure to air; and when they have lost it, they dissolve slowly and imperfectly in cold water. Soft soaps, on the contrary,

can never be dried by atmospheric exposure; they retain more or less water which renders them soft or gelatinous; and if after drying them with heat, we put them into cold water, they diffuse and dissolve. The causes of these differences are to be found; 1, in the nature of the alkaline base; 2, in that of the fat matter combined with this base.

1. *Influence of the alkaline Base.* If we saponify some of the same fat body with potash and soda, it is constantly observed that the soda soap is less soluble in cold water than the potash soap.

Influence of the fat matter which is combined with the alkali. Oil of olives, and particularly the less fusible animal fats, form, with soda, soaps which are much harder, than the soda soaps from rapeseed and animal oils; and, secondly, these oils form, with potash, much softer soaps, than those containing olive oil and the less fusible fats. M. Chevreul thinks that his researches completely explain these results. Let us consider, first of all, the action of cold water on the soaps, or in other words, on the salts which the stearic, oleic, and margaric acids form with soda and potash *.

The stearate of soda may be considered as the type of the hard soaps; it appears to experience no action from ten times its weight of cold water. The stearate of potash produces a thick mucilage with the same proportion of cold water.

The oleate of soda is soluble in ten times its weight of cold water; the oleate of potash forms a jelly with the double of its weight of water, and a solution with four times its weight. It is so deliquescent that 100 parts absorb, in an atmosphere saturated with moisture, 162 parts of water, at the temperature of 12° C.

The combinations of margaric acid with soda and potash, differ from those of the stearic acid, only in the somewhat greater action of water on them. The stearates, margarates, and oleates of the same bases can combine together in all kinds of proportions.

1. The soaps of human fat, and vegetable oils, are formed of oleates and margarates, whose respective proportions are very variable; and the soaps are softer, the more oleate, and the less margarate, they may contain. 2. The soaps of mutton suet, tallow, hog's lard, and butter, putting out of view the odorous salts they may contain, are formed not only of margarate and oleate like the preceding, but also of stearate; and it is remarked that their hardness is greater as the stearate predominates over the oleate. On the other hand, his experiments having shewn that it is chiefly the stearines which yield the stearic and margaric acids, and the oleine which yields the oleic acid, it follows; 1, that according to the proportion of the stearine to the oleine, contained in the sapo-

* He calls stearic acid, that which has the closest relations with the margaric acid, but which differs from it, in melting only at 70° C. and in containing less oxygen.

nifiable fats and oils, a proportion which may be inferred from their degree of fusibility, we may predict the degree of hardness or softness of the soaps produced; 2, that it is possible to imitate any *given soap*, by taking stearine and oleine in such proportions that the stearic, margaric, and oleic acids, which they are susceptible of furnishing by the action of alkalis, may be, in the same ratio, as in the fat of the soap proposed for imitation. Thus, by adding, to oils which would afford only soft soaps with soda, bodies abounding in stearine, such as the wax of the *myrica gale*, a substance produced in large quantity by a tree in Africa, and which was handed to M. Chevreul by an enlightened English traveller, we may imitate the soap of olive oil, which differs from the soap of rape-seed oil, only in containing less oleic acid.

These notions are obviously the fundamental base of the art of the soap manufacturer, and they may give him a degree of precision which he could not have had, while ignorant of the analysis of the fat part of soap into three acids, and of the reason why saponifiable fat bodies produce hard or soft soaps.

2d. *Section. Of Soaps considered with regard to Smell.*

Soaps are either *inodorous*, as those of human fat, and hog's lard, or *odorous*, as those of butter, oil of the dolphin, and suet. The odours of soaps are owing to principles absolutely distinct from the stearic, margaric, and oleic acids; for, on decomposing these soaps dissolved in water, by tartaric acid, and submitting the filtered aqueous liquids to distillation, we obtain products which have exactly the same smell as the soaps from which they are taken; and, in the second place, by washing sufficiently, the stearic, margaric, and oleic acids, we succeed in bringing these acids to such a state of purity, that when they are combined with potash and soda, they form absolutely scentless soaps.

The odorous principles of soaps have properties important enough to require being investigated. It is a remarkable fact, that they all possess a very strong acidity; to this property they join that of the volatile oils. Hence it may be asserted, that these acids form a new class of bodies, which are to the volatile oils, what the stearic, margaric, and oleic acids are to the fixed oils. Mr. Chevreul calls *phocenic acid*, the odorous principle of the soap of the dolphin oils; *hircic acid*, the odorous principle of the soap of mutton suet; *butiric acid*, the odorous principle to which the soap of butter of the cow, and even the butter itself, owe particularly their characteristic smell; he says, particularly, because these bodies contain besides, two other acids which he styles *capric and caproic acids.* He does not describe the processes by means of which he has obtained the three acids of butter in a state of purity; he remarks, however, that the method which he adopted, by giving more precision to the use of solvents in analysis in general,

is such as to exert a happy influence on young chemists who are engaged in organic analysis, by pointing out the steps to be followed when the object is to inquire if an organic matter should be regarded as a species of an immediate principle, or as a combination of several species, and by compelling them moreover to undertake trials which they would otherwise be apt to neglect.

Comparative examination of the Acids of Butter, of the phocenic and hircic Acids.—In the state of hydrate, the acids of butter and phocenic acid enter into ebullition at a higher temperature than that of boiling water. They may be distilled over without alteration. At 9° C. below zero, the phocenic, butyric, and caproïc acids are liquid, whilst at 15° C. above zero, the capric acid is in the form of small needles.

All these acids are colourless, and more or less odorous. The butyric and phocenic acids have a much stronger aromatic odour than the caproïc and capric acids. The smells of the first two are a little similar; but it is impossible to confound them after they have been once felt. The odours of the caproïc and capric acids resemble somewhat that of sweat; but the capric acid is distinguishable from the caproïc by something, which reminds one of the odour of a he-goat. All these acids have a burning taste, and a saccharine after-taste, like that of the nitric and muriatic ethers. At 25° C. the density of the butyric acid is 0.9675, that of phocenic acid 0.932, that of caproïc acid 0.923, and that of capric acid 0.910 at 18°.

They differ extremely in regard to their solubility in water. The butiric acid dissolves in it in all proportions, and the combination which results from 2 parts of acid and 1 of water, is denser than the latter liquid. The other acids are much less soluble.

100 of water dissolve 5.50 of phocenic acid;
1.50 caproic acid;
0.12 capric acid.

Alkohol dissolves the four acids in every proportion; and the solutions of the butyric and phocenic acids have an ethereous odour of the rennet apple, even when no sensible quantity of ether can be detected.

Butyric acid unites to hog's lard, and communicates to it the taste and smell of butter, but this aromatized fat soon loses its smell by exposure to air.

The composition of these three acids is in volume;

	Butyric acid.	Phocenic.	Caproic.
Oxygen	3	3	3
Carbon	8	10	12
Hydrogen . . .	11	14	19

The salts formed by the acids of butter and the phocenic acid, exhale, in the moist state, the smell peculiar to their acid, especially when slightly heated, or brought into contact with carbonic

acid. The odour of the butyrates is exactly that of fresh butter. The above salts are inodorous in the dry state, even when heated to 100° C. Their composition is easily deducible from their constituent acids. To shew, however, the great differences among the capacities of saturation of these acids, M. Chevreul details the following composition of the salts of barytes:

100	of butyric acid neutralize	97.58 of barytes.
100	— phocenic acid . . .	82.77
100	— caproic . . .	72.41
100	— capric . . .	56.45

100 parts of water at 20° C. dissolve	100 of phocenate of barytes
100 ———	36 — butyrate ———
100 ———	8 — caproate ———
100 ———	0.5 — caprate ———

The phocenate of barytes crystallizes in large polyhedrons, which appear to be octohedrons; the butyrate crystallizes in long prisms; the caprate in small globular crystals. The saturated solution of butyrate of lime contains 17 of salt for 100 of water at 15° C.; but at the boiling point it is less soluble, like its base, and forms a crystalline mass. The caproate of barytes evaporated spontaneously crystallizes in needles; evaporated at 18°, in hexagonal plates. The hircic acid gives to mutton broth the flavour which distinguishes it from that of beef. It forms a sparingly soluble salt with barytes, and a deliquescent one with potash.

The disagreeable smell of leather dressed with fish oil, is ascribed by M. Chevreul to the decomposition of the phocenic acid contained in this oil; for water, to which a few drops of this acid have been added, takes this odour after some time.

The stearic, margaric, and oleic acids, in their habitudes with heat, correspond to benzoic acid; the volatile acids, described in the present memoir, correspond to the acetic. Among the fatty bodies, not acid, there are some, like cholesterine (and ethal ?) which experience no alteration on the part of the most powerful alkalis; while other species, as the stearines, oleine, butyrine, phocenine, hircine, are all converted under the alkaline influence into a sweet principle on the one hand, and, on the other, into fixed or volatile acid fats; and it is possible that these latter species may be composed immediately of the same acids, and a sweet anhydrous principle acting as a base. However this may be, we cannot help approximating the substances which afford odorous acids by saponification to the group of those ethers, which are regarded as compounds of acids with alkohol.—*Ann. de Chim. et de Phys.* xxiii. 16.

12. *Facts subservient to the History of Cow-butter.* *By* M. Chevreul.

1. Fresh butter is a mixture of *butter-milk* and butter. To separate these two substances, the fresh butter must be kept some time melted in an oblong vessel. The butter milk sinks to the bottom: the melted butter is decanted into a filter, and received in water at 40° C. This mixture being agitated, is then left to settle. When the butter has again gathered on the surface of the water it is skimmed off, and filtered anew. In this state M. Chevreul has examined it as *pure butter.*

2. Butter-milk distilled, after being filtered, afforded an acid product, having the smell of frangipane, (a French perfume,) and it contained butyric acid, a trace of ammonia, and, apparently, some acetic acid.

3. One hundred parts of fresh butter, (from Murs, in Anjou,) were formed of,

Pure butter . . .	83.75
Butter-milk . . .	16.25

Pure butter indicates acidity by litmus paper. One hundred parts of boiling alkohol, specific gravity 0.822, dissolve 3.46 of butter. The solution powerfully reddens litmus.

Butter saponifies with potash *in vacuo,* without the production of carbonic acid. One hundred parts are saponified by sixty of potash, rendered caustic by lime; and there are obtained, acid fats insoluble in water, some sweet principle, and volatile acids which dissolve in water. The insoluble acid fats are the margaric, the stearic, (in small quantity,) and the oleic. In the state of hydrates, they weighed 88.5 parts, and they melted at 40°. C. The solution of the sweet principle and the volatile acids was distilled; the acids rose with most part of the water, and the sweet principle remained in the retort, mingled with the bi-tartrate of potash. When the sweet principle was separated from the tartar by alkohol, it weighed 11.85 parts. The volatile acids are three in number, the butyric, caproic, and capric.

M. Chevreul treated butter with alkohol, in order to determine the relation which its immediate principles bear to the fat bodies described in his former researches. For the minute details of his experiments, we must refer to the Memoir itself. His conclusions are the following:

"There exist, at least, two fluid substances in the oil of butter. 1. One soluble in every proportion in cold alkohol, not acid, and which affords by saponification the sweet principle, and the acids butyric, caproic, capric, margaric, and oleic." He gives this substance the name of butyrine, because it contains the butyric acid, (or its elements,) to which butter owes its odour.

2. The other has the properties of oleine.

On treating the oils of the dolphin and the porpoise with alkohol, in the same manner as the oil of butter, he reduced them to very different proportions. 1. Oléine. 2. A substance which he calls phocenene, analogous to butyrene, but which may be distinguished from it, because instead of affording, like this, three volatile acids, it yields only one, which he calls *phocenic acid.* In a former paper, he described this acid under the name of *delphinic acid.* The discovery of stearine, oléine, butyric acid, and the colouring principle, in butter, was announced to the Institute on the 19th of September, 1814.—*Ann. de Chim. et de Phys.* xxii. 366.

13. *Examination of the Blood and its action in the different phenomena of Life.* By J. L. Prevost, M.D., *and* J. A. Dumas.

The microscopic observation of the blood satisfied us, as we have previously shewn, that this liquid during life was nothing else than the serum, holding in suspension small regular and insoluble corpuscles. We have seen that these were uniformly composed of a central colourless spheroid, and of a species of membranous bag, of a red colour, surrounding this spheroid, from which it was easily separable after death. The central body is white, transparent, of a spherical form in animals with circular particles; of an ovoid form, in those with elliptical particles. Its diameter is constant in the first, but it varies very perceptibly in the second. It manifests also a great disposition to form aggregates, or ranges, in the form of a string of beads.

The coloured portion appears to be a kind of jelly easily divisible, but insoluble in water, from which it may be always separated by repose. It is likewise transparent, but much less so than the central corpuscle; and the fragments arising from its division are not susceptible of regular aggregation. As the attraction which keeps the red substance fixed round the red globules, ceases at the same time with the movement of the liquid, they can then obey the force which tends to unite them, and to form a net-work in whose meshes the liberated red colouring matter gets enclosed, as well as a great quantity of the particles which escaped this spontaneous decomposition. This mass, known under the name of *clot*, (cruor,) gradually allows to transude, as through a close filter, the liquid which it had imprisoned at the instant of its solidification, and sinks by reason of its weight. It suffers no other change besides, as long as no alteration is made in its texture; but if it be torn, and exposed to the action of a stream of pure water, this takes possession of the liberated colouring matter, and of the untouched particles, while the aggregate formed by the white globules, remains on the linen cloth or the searce, under the form of filaments, in which the microscope recognises the aspect

and structure of the muscular fibre, known to chemists by the expressive name of *fibrine.*

Such is the manner in which the materials of the blood are distributed; and these gentlemen have repeated their observations so many times during two years, that they entertain no doubts on the subject. It perfectly explains the inutility of the attempts made to insulate the colouring matter; and affords almost a certainty that this object will never be accomplished.

Three animal substances ought, therefore, to fix our attention in the chemical study of the blood; these are, the albumen of the serum, the white globule, and the colouring matter which envelops this.

They ascertained by experiment that the coagulation of albumen (white of egg,) takes place about 70° C. When once coagulated, the albumen, viewed in the microscope, presents the same white globules so often mentioned. The action of the voltaic pile clearly shews the state of combination which exists between albumen and the soda it contains. They ascribe the coagulation of albumen by spirit of wine, to the affinity of this menstruum for the caustic soda. They consider this as the most convenient method of obtaining albumen in a state of purity; and on studying it under this form, it is seen, by the action of different re-agents, to differ in no respect from fibrine. Lastly, the action of acids on albumen falls under the same head, although there are two modes of action to be distinguished. 1, The saturation of the soda; 2. The action of the acid on the albumen. The first cause explains the precipitation of white of egg by most acids; the second permits us to conceive why the phosphoric and acetic acids form an exception to this rule. In fact, these two agents dissolve, or at least reduce, to jelly, fibrine itself; and, consequently, must be very far from precipitating its alkaline solutions.

The colouring matter of the blood has engaged the attention of so many celebrated chemists, that they would long ago have exhausted its history, had they not been misled by a physical circumstance of great simplicity. It is singularly divisible in water, and passes even through filters; but by means of the microscope, its fragments are easily discovered, and they fall down or repose, in the form of a red deposit, of considerable density. This property of colouring water without disturbing its transparency, made chemists believe that water could dissolve this substance, and they subjected the red liquor to the action of reagents whose effects have never been satisfactory. The colouring matter of blood appears to be formed of an animal substance in combination with the peroxide of iron. Were we to abide by the experiments hitherto made, we should believe that this matter is albumen; but as only a confused mixture of red matter has been operated on of white

globules and albumen of the serum, we can by no means regard the question as decided. They therefore conceive that all the processes pointed out in the memoirs of Berzelius, Brande, and Vauquelin, for insulating the colouring matter, are more or less illusory.

By reflecting on the properties of the several animal matters, which the blood contains, their estimation is much easier than had been heretofore supposed. In fact, the blood, after issuing from its vessels, separates into two portions, the clot, and the serum. The first is composed of the totality of the particles, (corpuscles,) and a quantity of serum more or less considerable, according to the space of time during which it has been left in repose; but in no case does it contain any other substance, unless it be in certain morbid affections, which they do not at present examine. As it is very easy to subject the serum to an exact analysis, it is no less so to correct the error which its mixture introduces into the results of the analysis of the clot. They have thus made several analyses, for the details of which we must refer to their memoir. We have assembled the results in the following table.

	Serum.		Blood.		
Mammifera.	Water.	Albumen & soluble salts.	Water	Particles.	Albumen & soluble salts.
Callitriche	998	92	7760	1461	779
Healthy man	900	100	7839	1292	869
Do. from vena porta of a criminal just executed.	905	95	8014	1142	844
Guinea pig	900	100	7848	1280	872
Dog	926	74	8107	1238	655
Cat	904	96	7953	1204	843
Goat	907	93	8146	1020	834
Calf	901	99	8260	912	828
Rabbit	891	109	8379	938	683
Horse	901	99	8183	920	897
Birds.					
Pigeon	945	55	7974	1557	469
Duck	901	99	7652	1501	847
Hen	925	75	7799	1571	630
Crow	934	66	7970	1466	564
Heron	932	68	8082	1326	592
Cold-blooded animals.					
Trout	923	77	8637	638	725
Gadus lota	931	69	8862	481	657
Frog	950	50	8846	690	464
Land Crab	904	96	7688	1506	806
Common eel	900	100	8460	600	940

We have only to glance our eyes over these results to be satis-

fied that it is impossible to draw from them general conclusions relatively to the composition of the serum. This liquid varies in the same animal, and also from one animal to another, without its being possible to connect this character with the physiological condition of the individual. But this is not the case with the particles. In the greater number of cases, their quantity exhibits a certain relation to the heat developed by the vital action. The following table renders this position pretty evident. In it are assembled the weights of the particles in one thousand parts of blood, the habitual temperature of the rectum, the number of pulsations of the heart in a minute, and the number of inspirations in the same time. To complete our knowledge on this subject, the ratio of the total weight of the blood in circulation to the weight of the animal is wanting. MM. Prevost and Dumas are now engaged in this difficult, and hitherto inaccurate, estimate, but one, indispensable to the application of the facts here detailed.

Name of the Animal.	Weight of particles in 1000 of blood.	Mean temperature.	Normal pulse per minute.	Normal respiration per minute.
Pigeon	1557	42° C.	136	34
Hen	1571	41.5	140	30
Duck	1501	42.5	110	21
Crow	1466	"	"	"
Heron	1326	41	200	22
Ape	1461	35.5	90	30
Man	1292	39	72	18
Guinea pig	1280	38	140	36
Dog	1238	37.4	90	28
Cat	1204	38.5	100	24
She Goat	1020	39.2	84	24
Calf	912	"	"	"
Rabbit	938	38	120	36
Horse	920	36.8	56	16
Sheep	900	38	"	"
Trout	638	"	"	"
Gadus lota	481	That of the place.	"	36
Frog	690	9° in a place at 7°.5	"	20
Turtle	1506	That of the air.	"	3
Eel	600	"	"	"

By drawing only a little blood from a large animal, these gentlemen tried to determine the relative natures of arterial and venous blood. The results on a sheep were as follows :—

	Serum. Water.	Album.	Blood. Water.	Particles.	Album.
Arterial blood from the carotid	915	85	8293	935	772
Venous from the jugular	915	85	8364	861	775

Those of the dog and of the cat present differences in the same direction. .10,000 of arterial blood usually contain 100 of globules, beyond what venous blood does. They took care in these analyses, always to draw off the venous blood before the arterial, lest the venous absorption, if it occurred, might come to favour the relation, whose existence they have here indicated. The following are the general conclusions drawn from their memoir.

1. That the arterial blood contains more particles (corpuscles) than the venous blood.

2. That birds are the animals whose blood is richest in corpuscles.

3. That the *mammifera* come next; and it would appear that the *carnivora* have more of them, than the *herbivora*.

4. That cold-blooded animals possess the fewest.

Lastly, a direct proof is obtained in their experiments, of venous absorption, after blood-letting. Thus, a robust cat in good health was powerfully blooded from the carotid; the blood afforded

	Serum. Water.	Album.	Blood. Water.	Part.	Album.
	900	100	7938	1184	878
After 2 minutes, blood of jugular,	916	84	8092	1163	745
Idem, after 5 minutes . .	915	85	8293	935	772

Ann. de Chim. et de Phys. xxiii. 50.

Messrs. Prevost and Dumas have published, in the same number of the *Annales*, an additional paper on the blood; from which we have extracted the following facts.

Among the causes which may have an influence on the proportions, or the nature, of the constituent principles of the blood, there are certain pathological accidents to which, in the sequel, they were led to pay particular attention. The secretory apparatus which it traverses, has always excited the curiosity of physiologists. It would seem, at the first view, that what occurs in a secreting organ, could not be appreciated with accuracy, could we not subject to analysis the blood which is carried into it, that which leaves it, and, lastly, the secreted liquid itself; and the slightest reflection unanswerably proves, that the hope of obtaining such data is vain. But in certain cases there is a legitimate method of eluding this difficulty, and we shall here explain it in a few words.

The blood distributed to a secreting organ arrives at it in a certain state, experiences in its passage through it, a certain change, and returns into the circulating mass, where it is mingled with the whole sanguine liquid. But if by any means whatsoever, the secreting organ be deprived of its influence, the fluid travers-

ing it would undergo no more alteration in its specific character, than if it passed through an apparatus of simple capillary vessels. Every aliquot portion of this fluid would therefore induce, in the circulating mass, a change at first entirely inappreciable; but at the end of a certain period, a multitude of impressions of a like kind having ensued, it might be presumed, with some reason, that the blood would resemble, in whole, or in part, the fraction which flows in the ordinary state to the secretory organ. It might then be easily submitted to analysis, and its composition be compared with that of the same liquid in its regular condition.

At the first view, it seems difficult to neutralize the action of a secretory organ; and whatever measures be adopted for the purpose, they will always be open to criticism. The removal of the organ puts an end to all these objections, and fulfils perfectly the above conditions. M. Richerand examined the effects produced by the ligature of the ureters, and he found that the secretion of urine continued; that these canals became gorged, as well as the kidneys, and that a general affection, to which he gave the name of *urinary fever*, soon supervened, the necessary consequence of which was death, at the end of a few days. But this operation leaves us in doubt, whether the urine was formed, and then re-absorbed, or if the kidney discharged its functions in only a partial manner. He next proceeded to the removal of the kidneys, which afforded him some singular results. If only one be removed, the animal is not affected; but whenever both these organs come to fail at the same time, it sinks under a pathological influence, which terminates in a fatal manner after a few days. The gall-bladder is found, on dissection, to be gorged; and this secretion seems to M. Richerand to replace, in these circumstances, the action of the kidneys. In repeating experiments of this kind, MM. Prevost and Dumas operated chiefly on dogs and cats, as rabbits supported the operation very ill; which in other respects presents no real difficulty. A lean animal is selected, and an incision is made through the integuments of the abdomen, which commencing at the inner third (*tiers internes*) of the last rib, and some lines below it, extends more or less, according to the size of the animal, along the internal edge of the *quadratus lumborum* muscle. The index of the left hand is introduced into the wound, taking care not to pierce through the *peritoneum*. The kidney is gently detached from its adhesions, and extracted by means either of a hook, or polypus forceps. It is now separated from the body, having previously fixed a ligature round its vessels. A few stitches of a suture restore the divided muscles into contact, and prevent all danger of hernia. The skin is stitched in the same way.

When we wish to observe the physiological phenomena which follow the removal of the kidneys, it is better to cut out first the

right kidney, on account of its connexions with the liver, and to allow an interval of fifteen days between this operation and the following. The first, if well performed, affects in no respect the health of the animal, whether it be carnivorous or herbivorous. At the end of three days the wound is cicatrized, and no unpleasant symptoms appear. When the animal loses the second kidney, it is rarely affected before the third day. During this interval the wound is closed; the animal resumes its liveliness and activity; it eats well, drinks little, sleeps as usual; its temperature, breathing, and pulse do not vary in any very decided manner. But on the expiration of this period, brown, copious, and very liquid stools, as well as vomitings of the same nature, announce the disturbance introduced into the constitution. Febrile exacerbations raise the heat to 43° C., while at other times it sinks to 33°. The pulse becomes small, hard, and rapid; the number of beats amounting occasionally to 200 in a minute. The respiration is frequent, short, and, at the last periods, oppressed. Finally, all the above symptoms are aggravated, the debility augments, and the animal dies between the fifth and the ninth day. If the two kidneys be extracted at once, the resulting inflammation abridges this period, and the subject does not last beyond the fourth or fifth day. The examination of the dead body, exhibits constantly the following appearances. 1. The effusion of a clear limpid serum into the ventricles of the brain; the quantity amounting sometimes to an ounce, in a dog of middle size. 2. The lungs seem to be a little denser than in the healthy state; and the *bronchia* contain much mucus. 3. The liver appears more or less inflamed, and the gall-bladder is filled with a greenish, or deep-brown bile. 4. The intestines contain abundance of liquid fæcal matter, of the same colour with the bile. 5. The bladder of urine is powerfully contracted. To these symptoms there is sometimes superadded, particularly in herbivorous animals, a dangerous inflammation from the operation.

Considering that a dog of middle size, in its healthy state, secretes a dram and upwards of urea in the 24 hours, MM. Prevost and Dumas entertained the hope of deciding the question relative to the functions of the kidney, by the examination of the blood of the *nephrotomized* animals. They were bled when their feeble and languishing health made it be presumed that they had only a short time to live: and their blood was examined with attention. It was first of all perceived to be more serous than the blood of the same animals in the healthy state, and the serum itself contained a more considerable proportion of water. This ought to be expected, if we bear in mind that the cutaneous transpiration is null in these animals, and that it cannot therefore restore the equilibrium which the annihilation of the kidneys has just destroyed. The serum and clot, dried as usual, were treated with boiling water as long as this menstruum had any perceptible action on them

The evaporated washings were subjected to alkohol, which dissolved the matter distinguished by the name of *muco-extractive substance*, by Dr. Marcet, one of the first philosophers who characterized it. M. Berzelius has since shewn, that this product might be considered as a mixture of lactate of soda, and a peculiar animal matter. Healthy blood having been exposed to perfectly similar treatment, it was observed, that the blood of the animals operated on afforded an alkoholic residuum twice more considerable. In both cases, it was of a brown colour, soluble in water and alkohol, strongly absorbent of moisture from the air, and precipitating the acetate and nitrate of lead; but that obtained from the blood of the nephrotomized animals concreted into a white crystalline mass with nitric acid. Water dissolved almost entirely the latter product, and the aqueous solution saturated by means of a little carbonate of soda then evaporated, furnished a saline residuum from which alkohol separated anew the animal matter, which appeared with its primitive properties. These different characters, indicated the presence of an animal matter susceptible of combination with oxide of lead, as also of a considerable quantity of urea, and a pretty large proportion of lactate of soda. When the combustible ingredients were destroyed by the action of heat, the last substance left much carbonate of soda.

The urea was now purified, by converting the residuum of the alkoholic treatment, into nitrate; and this compound was left on unsized paper for some hours. Thus the whole lactate of soda was separated by its deliquescence, and sinking into the paper. On re-dissolving the nitrate in water, there remained a small residuum, which appears to be a combination of nitric acid with the animal matter, precipitable by lead. The evaporation of the liquid re-produced the nitrate of urea, in perfectly white pearly spangles. It is easy by the known methods, to extract from them, the urea in its pure crystalline state. By igneous analysis with oxide of copper, MM. Prevost and Dumas ascertained the urea to be the same as that obtained from urine.

Important physiological corollaries may be deduced, from the existence of urea in the blood, independently of the action of the kidneys. This organ appears to be merely an eliminating surface, analogous to the skin, as Dr. Rollo long ago supposed *. We are still ignorant of the place where urea and the several ingredients of the urine are formed. If any thing can throw light on this subject, it must, probably, be the examination of different urines in very decided pathological cases. In fact, every chemist knows that the urine of patients labouring under chronic hepatitis, contains little or no urea; which would seem to prove, that the functions of the liver are necessary to its formation.

The true seat of diabetes has been the subject of many learned

* On Diabetes, p. 308.

discussions, which have, however, left the matter undecided. Some experiments, to be afterwards detailed, lead MM. Prevost and Dumas to think; 1. That the urea is eliminated by the kidneys in proportion as it is formed; 2. That when this organ is extracted, the blood retains the whole of the urea. Now if it be admitted, that the same thing happens with the saccharine matter, it may without difficulty be conceived that in the cases where the kidney does its duty, the whole sugar disappears from the blood, and that in those where it performs its functions in a partial manner, sensible quantities of sugar will still be found in that liquid. It cannot be expected to be found in any very notable mass, as long as the action of the kidney has not been entirely destroyed. These several considerations seem to them to establish that it is with the sugar of diabetic persons as with the urea, and they have some reasons for thinking that this principle exerts a diuretic action, from which the chief symptoms of diabetes may be deduced. We may also find here illustrations of some phenomena of the gout, which confirm the discovery itself. The presence of concretions of lithate of soda in the joints might have led us to think that this principle existed in the blood. We know besides, that the urinary secretion is loaded with a large portion of lithic acid, when the paroxysm affects the kidneys, and that the articulations briskly attacked, are the only ones which contain the concretions of the alkaline lithate. If analysis proved, that at the beginning of the attack the blood contains more lithic acid than the kidney can possibly draw off, we would recognise in the general disturbance which forms the commencement of the paroxysm, the result of this morbid action of the blood, and in the point affected, a momentary seat of the secretion. The characters of the urine will henceforth acquire a very great interest, as they may serve to indicate the state of the mass of the blood, and the kind of alteration which this important fluid has undergone.

Physiologists, curious of ascertaining for themselves the truth of the facts announced in this Memoir, will not experience much difficulty. Five ounces of blood from a dog which had lived without kidneys for only two days, afforded more than twenty grains of urea; and two ounces of the blood of a cat, in the same circumstances, yielded more than ten grains of it. These quantities are perfectly appreciable by the least experienced chemists. The above analyses have been successfully repeated by M. Vauquelin; and his pupil M. Segalas has shewn that urea is a very powerful diuretic.

14. *On the Electro-Magnetic Multiplier of Schweigger, and on some of its applications. By* M. Oersted.

Immediately after the discovery of electro-magnetism, M. Schweigger, Professor at Halle, invented an apparatus well adapted

for displaying, by means of the magnetic needle, the feeblest electrical currents. The effect of this multiplier is founded on the equal action exercised on the needle by all the parts of a conducting wire, when it transmits a current. When a portion of this wire is bent, like *a b c*, (Fig. 1.), if the two branches *a b* and *b c* are in a vertical plane, and if a needle *d e* is suitably suspended in the same plane, we may easily conceive, that the needle must receive an impulsion double of what one of those branches would have communicated. In fact, the impulsions given to the needle by the two horizontal portions of the wire are added together. To be satisfied of this, we have merely to observe, that in the actual arrangement, these portions are percurned by the electrical current in two different directions. The upper wire, and the under wire cause the declination of the needle to the two opposite sides only in the case where electricity moves in it, in the same direction. We shall therefore increase the effect by giving the conducting wire several convolutions round about the needle, as is shewn in Fig. 2. It is this which constitutes the electro-magnetic multiplicator.

Fig. 1.

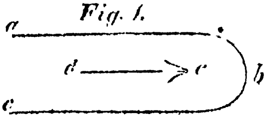
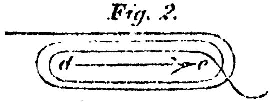


Fig. 2.



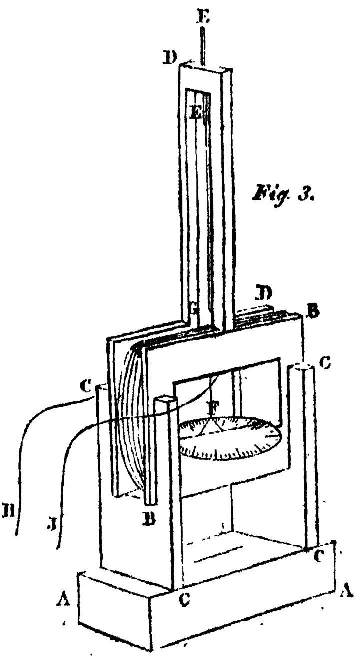


Fig. 3. represents this apparatus according to the form which M. Oersted has given it, which however differs from that of

M. Schweigger, merely in parts not essential. AA is the foot of the instrument; CC,CC, are two uprights, which carry a frame BB, in the border of which there is a groove, where the successive turns of the multiplying wire lodge. DD is an upright, destined to support the wire, from which the needle is to be suspended. All these parts are of wood. EE is a wire of metal, which passes with friction through a hole, pierced in the upper part of the upright DD. To this, metallic wire is attached by a little wax, the silk-worm thread EF; the latter bears at its extremity a small (folded) double triangle of paper, on which reposes the little magnetic needle. At G, is a hollow cylinder, in which the thread of suspension passes freely, and which prevents the multiplying wire from touching it. There may be seen also beneath the needle, a graduated circle for measuring the deviations. The multiplying wire is of silvered copper; its thickness is one-fourth of a millimetre (about 0.01 of an inch Eng.). *It is wrapped through its whole length in silk thread.* Thus all electric communication is avoided between the different parts of this wire, which are wound over one another in the groove of the frame B B. H and J represent the two extremities of the wire.

The use of this apparatus may be conceived almost without explanation. To multiply the effect which a galvanic arrangement has on the needle, the communications have only to be established, so that the multiplying wire may become a part of the circuit. The electricity developed by the contact of two discs, the one of zinc, and the other of copper, when nothing but water is employed for the liquid conductor, is perfectly appreciable with this apparatus. We may in the same way make galvanic actions manifest, which would be too feeble to be perceived by employing a prepared frog. When we wish to render evident an extremely weak action, which gives a scarcely visible deviation, we must open the circuit immediately after closing it, and then close it anew every time that the needle is on the eve of terminating the return of the preceding oscillation. The apparatus may be also rendered more delicate by placing in HH a small magnetized needle, in the position requisite for diminishing the force with which the suspended needle tends to preserve its direction. When it is wished to make use of the multiplier for electro-magnetic actions somewhat more considerable, much thicker conducting wires must be employed. Without this precaution, there might be, instead of an increase, a diminution of effect, caused by the imperfection of the conductor. M. Poggendorff has made a happy application of the multiplier to examine the order of the conductors in the galvanic series. He found also that some metals gave, at the instant of their being plunged into concentrated nitric acid, an effect contrary to what is manifested some moments afterwards. This change does not take place with dilute nitric acid. The metallic couples which shewed

this peculiarity, are lead and bismuth; lead and tin; iron and bismuth; cobalt and antimony. M. Avogradò says, that the effect which occurs at the instant of immersion of the metals in the concentrated acid, is the same with that obtained with the dilute acid, and that it is only in the long run that the contrary effect is exhibited.

If we plunge, at two different instants, two pieces of *the same metal* into an acid capable of attacking them, that of the two pieces first plunged will comport itself towards the other, like the most positive metal. Two plates of zinc, with dilute sulphuric or muriatic acid, answer well. Of the metals in the following series, each comports itself as a negative body, in reference to all those which follow it; and as a positive body with regard to all those which precede it, platinum, gold, silver, arsenic, antimony, cobalt, nickel, copper, bismuth, iron, tin, lead, and zinc. These results do not agree with those formerly obtained with Volta's condenser; but the difference may arise from the degree of concentration of the acid. As gold and platinum are not attacked by nitric acid, these metals give no electric developement, unless aqua regia be used for them. This is a new proof of the necessity of a chemical action for the production of a voltaic current.—*Ann. de Chim. et de Phys.* xxii. 358.

15. *On some new Thermo-electric Experiments made by* Baron Fourier *and* M. Oersted.

M. Seebeck has proved that an electrical current can be established in a circuit formed exclusively of solid conductors, by disturbing merely the equilibrium of temperature. We are thus in possession of a new kind of electrical circuits, which may be called *thermo-electric*, in distinction of the galvanic circuits, which it may be henceforth proper to denominate *hydro-electric*. A question interesting to electro-magnetism, as well as to the theory of the movement of caloric in bodies, here presents itself. The object is to examine, if the thermo-electric effects may be increased by the alternate repetition of bars of different materials, and how we must proceed in order to obtain such effects. It does not appear that the author of the discovery of *thermo-electricity* has hitherto directed his inquiries towards this point. The apparatus which MM. Fourier and Oersted first employed, was composed of three bars of bismuth and three others of antimony, soldered alternately together, so as to form a hexagon, constituting a thermo-electric circuit, which includes three elements. The length of the bars was about 12 centimetres (4.7 inches Eng.), their breadth 15 millimeters (0.59 of an inch), and their thickness 4 millimetres (about 0.16 of an inch.) This circuit was put upon two supports, and in a horizontal position, observing to give to one of the sides

of the hexagon the direction of the magnetic needle. A compass needle was then placed below this side, and as near to it as possible. On heating one of the solderings with the flame of a lamp, they produced a very sensible effect on the needle. On heating two solderings, not contiguous, the deviation became considerably greater. When, lastly, the temperature of the three alternate solderings was heated, a still greater effect was produced. They likewise made use of an inverse process, that is to say, they reduced to zero, by melting ice, the temperature of one, or more solderings of the circuit. It is readily conceived that, in this case, the solderings which are not cooled must be regarded as heated in reference to the others. This manner of operating allows the different experiments to become comparable; otherwise the laws of this class of phenomena could not be discovered. By combining the action of the ice with that of the flame, namely, by heating the three solderings that are not refrigerating, they arrived at a very considerable effect indeed; the deviation of the needle amounted then to 60°.

They afterwards continued these experiments with an apparatus composed of 22 bars of bismuth, and 22 of antimony, much thicker than those of the hexagon; and became convinced that each element contributes to the total effect. Having opened the circuit in one point, they soldered to the separated bars, small brass cups, which were subsequently filled with mercury, in order to establish at pleasure a sure communication between their extremities by means of metallic wires. A copper wire, a decimetre in length, and a millimetre in thickness, was nearly adequate to restore the complete communication. With two similar wires placed alongside of each other, the communication was perfect. A wire of the same diameter, but more than a metre long, transmitted the current pretty well; while a wire of platinum, half a millimetre in diameter (about $\frac{1}{50}$ of an inch), and 4 decimetres long, established the communication so imperfectly, that the deviation of the compass-needle did not amount to 1°. When the interposed body was a slip of paper moistened with a saturated solution of soda, no appreciable effect was observed. It is worthy of remark, that an apparatus capable of affording electro-magnetic effects of such magnitude, produced no sensible chemical action or ignition. They further add, that the effect of the complex electro-magnetic circuit, is much inferior to the sum of the insulated effects, which the same elements could produce when employed in the formation of simple circuits.

Details of the Experiments of the preceding note, and ulterior Observations.—The bars made use of in the following experiments were parallelopipeds, having for their transverse section, a square 15 millimetres in each side (about 0.6 of an inch square.) They

composed a rectangular circuit *a b d c* (Fig. 4.) One half, *a c d* was antimony; the other *a b d* bismuth. These two halves were soldered together. There were thus two adjacent sides of antimony, and two of bismuth. The length of the greater side was 12 centimetres; that of the other 8. The circuit having been placed horizontally on supports, with two of its sides in the direction of the magnetic meridian, the needle was placed upon one of them. After leaving the apparatus alone, to allow it to assume throughout the equilibrium of temperature, ice was put on one of the two solderings which joined the heterogeneous metals. The needle then showed a deviation of 22° or 23°, the atmospheric temperature being at 14° C. When the temperature of the air was 20°, they observed a deviation of 30 degrees.

2*d Experiment.*—Another circuit (Fig. 7.) was formed nearly of the same size, but in which the opposite sides were of the same metal; for example, *a b* and *c d* were bismuth, *a c* and *b d* antimony. The apparatus was put in action by placing ice on two opposite angles. This circuit produced a deviation of 30° or 31°, in the same circumstances in which the simple circuit afforded only 22° or 23°. In this circuit the temperature soon comes to an equilibrium, so that the thermo-electric effect appears weaker in it than it would have been, but for this circumstance.

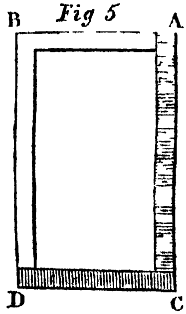
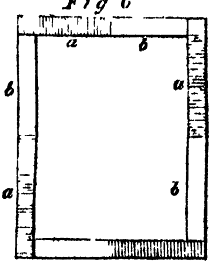
Fig 5


Fig 6


3*d Experiment.*—A circuit A B D C (Fig. 5.) whose contour had double the length of that of the circuit in the first experiment, was brought into action by ice placed on one of its solderings. The deviation was only from 13° to 15°, under the same conditions, in which the circuit (Fig. 4.) gave 22° to 23°.

4*th Experiment.*—Another circuit (Fig. 6.) was formed of the same length with that of the preceding experiment, but four alternations were given it, or four thermo-electric elements *a b; a* denotes antimony and *b* bismuth. This circuit was made active by

ice placed on the solderings at every two intervals. The deviation of the magnetic needle was in this case $31\frac{3}{4}°$, in the same circumstances in which the simple circuit of equal length, in the third experiment, produced a deviation of only 13° or 15°. But it must be recollected that the circuit of the second experiment, which had only half the length of circumference, and half the number of elements, afforded nearly the same effect. Hence we perceive, what will be confirmed by ulterior experiments, that the deviations of the needle, produced by the thermo-electric circuit, augment with the number of elements when the length of the circuit remains the same, but that they become feebler in proportion as the length is increased. It is seen, moreover, that these two effects counterbalance each other, as will be made more evident in the sequel. Hence the effect of a circuit does not change when the length of its circumference augments in the same proportion as the number of its elements; or in other terms, that elements of equal length, form circuits which produce equal deviations, whatever may be the number of these elements. These results were confirmed, by comparing the effects of circuits of one, two, three, four, six, thirteen, and twenty elements. In order to form complex circuits capable of producing a very great effect on the magnetic needle, very short elements must be employed. One inconvenience, it is true, will thence arise; the equilibrium of temperature will be rapidly restored in the circuit, unless with regard to the alternate solderings, one be put in communication with a continual source of heat, and the other, with a continual source of cold. The thermo-electric action may be rendered sensible by means of the electro-magnetic multiplier, but the effect is not so good as by the preceding simple arrangement. Hence it is inferred that the thermo-electric circuit contains electrical forces, in much greater *quantity* than any hydro-electric circuit of equal size; while, on the other hand, the *intensity* of the forces in the latter circuit is much more powerful than in the other. In the first electro-magnetic experiments it was well seen that the deviation of the compass-needle, produced by the electrical current, was regulated by the *quantity* of the electrical forces, and not by their *intensity (action électro-métrique.)* The considerable deviation, therefore, which the thermo-electric current produces, is an indication of the great quantity of force which it contains. They tried the effect of the complex circuit on the needle of the multiplier, and found that it increased considerably with the number of the elements of the circuit, even in cases where this multiplication of the elements added nothing to the effect on the simple compass needle. It appears, therefore, that the intensity of the forces increases, in the circuit, with the number of its elements, precisely as happens in the pile of Volta. The circuit had no sensible effect, however, on the needle, when the commu-

nication was established by the wire of the multiplier. The thermo-electric circuit afforded no sensible taste, when it was made to act on the tongue; but on a prepared frog, it exhibited the effect of two metals slightly dissimilar. This result shews the electroscopical delicacy of the nerves of the frog.

Fig. 4.

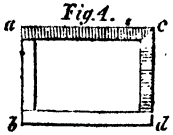
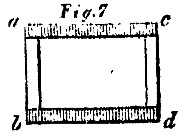


Fig. 7



These philosophers conclude, that the thermo-electric circuit will afford a quantity of electricity incomparably greater than what could be derived from any other apparatus hitherto invented. "If, by means of the ancient circuits," say they, "water, acids, and alkalis have been decomposed, it is not beyond the limits of probability to suppose, that by the new ones, the metals themselves may come to be decomposed; and thus the great revolution in chemistry, commenced with the pile of Volta, will be completed."—*Ann. de Chim. et de Phys.*, xxii. 375.

18. *On the Climate of the Canaries, by* M. de Buch.

In this long memoir, which we have no room to extract, we find the following table of the mean temperatures for each month, at Sainte-Croix-de-Teneriffe. It is the result of very exact observations, made by Don Francesco Escolar.

	Centigrade.		Centigrade.
January	17.69°	July	25.15°
February	17.94	August	26.05
March	19.54	September	25.24
April	19.62	October	23.70
May	22.29	November	21.35
June	23.27	December	19.06

Ann. de Chim. et de Phys., xxii. 281.

19. *Reflections on Volcanoes. By* M. Gay Lussac.

Two hypotheses may be framed concerning the cause which maintains volcanic phenomena. According to the one, the earth should be still in a state of incandescence at a certain depth below its surface, as the observations recently made in mines, on the progressive increase of its temperature, would seem to indicate; and this heat should be the principal cause of volcanic phenomena. M. Gay Lussac assigns valid reasons for the rejection of this hy-

pothesis. According to the other, their principal cause is a very energetic, and as yet unsaturated, affinity between substances, which a fortuitous contact would permit them to obey; whence would result a heat adequate to melt the lavas, and to elevate them, by the pressure of elastic fluids, to the surface of the earth*.

On consulting analogy, the substances capable of penetrating into the volcanic fires in masses sufficient to feed them, are air or water, or both together. M. Gay Lussac shews satisfactorily enough, that the instrumentality of air need not be taken into account. That water penetrates into the fires of volcanoes cannot be called in question. There is no great eruption, which is not followed with an enormous quantity of aqueous vapours, which condensing afterwards, by cold, on the summits of the volcanic mountains, fall back again in abundant rains, accompanied with frightful thunders, as was witnessed in the famous eruption of Vesuvius in 1794, which destroyed *Torre del Greco*. There have also been observed in the daily ejections of volcanoes, aqueous vapours, and muriatic acid gas, whose formation it is hardly possible to conceive in the interior of volcanoes, without the concurrence of water.

Admitting that water may be one of the principal agents of volcanoes, it remains for us to examine the part which it probably plays. On the second hypothesis, it is necessary for the water to meet in the interior of the earth substances to which it has an affinity, sufficiently powerful for its decomposition, and for giving rise to a considerable disengagement of heat.

Now the lavas vomited by volcanoes, being essentially composed of silica, alumina, lime, soda, and oxide of iron, all oxidized bodies, and having no longer an action on water, it is not in this state, that they must have originally existed in the volcanoes; and from what is now known of their true nature, since the beautiful discoveries of Sir H. Davy, they should exist there, if not wholly, at least in part, in the metallic state. In this case it can without difficulty be conceived, that by their contact with water, they may be decomposed, be changed into lavas, and produce sufficient heat, to explain the greater part ot volcanic phenomena. One of the consequences, and perhaps the most important, would be the disengagement, through the crater of the volcano, of an enormous quantity of hydrogen, either free or combined with some other principle, if it be really water which maintains by its oxygen, the volcanic fires. It does not, however, appear that the disengagement of hydrogen is very frequent in volcanoes. Although during his residence at Naples, in 1805, with his friends, MM. Alexandre de Humboldt, and Leopold de Buch, M. Gay Lussac

* This idea is due to Sir H. Davy. It was a natural inference from his discovery of the metallic bases of alkalis and earths.—*Editor*.

was a witness at Vesuvius of frequent explosions which projected the melted lava more than 200 metres high, he never perceived any inflammation of hydrogen. Each explosion was succeeded by volumes of a thick and black smoke, which would not have failed to take fire, had they been formed of hydrogen, as they were traversed by red matters more highly heated than would have been necessary for their accension. This smoke, the evident cause of the explosions, contained therefore other fluids than hydrogen; but what was its true nature*?

Admitting, says he, that it is water which furnishes the oxygen to the volcanoes, it must, since its hydrogen is not disengaged in a free state, at least most usually, become engaged in some new combination. This cannot be into any compound inflammable on contact of air, by means of heat; but it might happen to form muriatic acid with chlorine. We have in fact several observations at the present day, on the presence of this acid in the vapours of Vesuvius; and according to that excellent observer M. Breislack, it should be at least as abundant in them, as sulphurous acid. M. Menard de la Groye, and M. Monticelli regard the presence of muriatic acid in the vapours of Vesuvius, as incontestable. M. Gay Lussac suggests that this position should be further verified by putting water containing a little potash, in open vessels, at several places of this volcano. This water would gradually become charged with acid vapours, and at the end of some time, it would be easy to determine their nature.

If the combustible metals (silicium and aluminum) be not in the state of chlorides, the muriatic acid must then be a secondary result. It proceeds from the action of water on some chloride (probably that of sodium,) an action which is promoted by the mutual affinity of the oxides. The production of muriatic acid by the concurrence of water, and some oxide, on a chloride, ought to be very frequent in volcanoes. The lavas contain chlorides, for they exhale them abundantly on contact of the air. MM. Monticelli and Covelli have extracted by simple washings with boiling water, more than 9 *per cent.* of sea salt from the lava of Vesuvius of 1822. It exhales from the mouth of volcanoes; very fine crystals of it being seen in the scoriæ that cover the incandescent lava.

It is known that the lava, especially those which are spongy, contain much specular iron. It forms occasionally a kind of veins; and coats with beautiful micaceous crystals the walls of galleries still too hot for remaining long in them. Now, the peroxide of iron being very fixed at much higher temperatures

* We are surprised at the above inference. Surely M. Gay Lussac cannot have forgotten Sir H. Davy's experiments on the non-combustibility of hydrogen, when mixed with muriatic acid gas, &c.—*Editor.*

than that of lava, it is by no means probable that it has been volatilized in that state. It has, most likely, been primitively in the state of chloride. If, indeed, we take protochloride of iron which has been fused, expose it to a dull red heat in a glass tube, and then pass over its surface a current of steam, we shall obtain much muriatic acid and hydrogen gases, and there will remain in the tube black deutoxide of iron. The perchloride of iron is very volatile; and becomes so hot with water, that, on the large scale, the mixture might become incandescent. If chlorides of silicium and aluminum exist in the bowels of the earth, their action with water would be far more energetic. M. Gay Lussac does not believe in the agency of sulphur in volcanoes; and finds a difficulty in accounting for the presence of sulphurous acid, if it really exist. He shews that basalts, cannot owe their black colour to carbon; for in that case, by ignition, metallic iron would be formed in them. He thinks that it is sea water which most usually penetrates into the heart of volcanoes. He illustrates the extent of the earthquakes which accompany eruptions, by the vibratory effect produced on a long beam, when one end of it is struck with a pin-head; and by the shaking of vast edifices, and of even the profound quarries at Paris, by the rattling of carriages on the streets. Why should it be astonishing, therefore, concludes he, that a very strong commotion in the bowels of the earth shall make it tremble throughout a radius of several hundred leagues.—*Ann. de Chim. et de Phys.* xxii. 415.

Art. X. ANALYSIS OF SCIENTIFIC BOOKS.

Lectures on Comparative Anatomy, in which are explained the preparations in the Hunterian Collection, illustrated by Engravings; to which is subjoined "Synopsis Systematis Regni Animalis nunc primum ex Ovi Modificationibus propositum," by Sir Everard Home Bart. V.P.R.S., F.S.A., F.L.S., &c.

These lectures were read before the College of Surgeons, in the years 1810, 1813, and 1822, and they contain a connected view of those discoveries and researches in physiology and comparative anatomy, communicated by the author to the Royal Society, and which, since the year 1784, have from time to time made their appearance in the Philosophical Transactions. They now form four splendid volumes in quarto, two of letter press, and two of illustrative engravings, from the admirable drawings of Messrs. Bauer and Clift.

Although the first two volumes were published several years ago, we are not aware of their having been noticed in any periodical journal or review; we shall therefore endeavour to give a succinct account of the whole work, which is the more necessary, as many of the inquiries, commenced in the first volume, are continued and concluded in the third. The following is the order in which the author has arranged his subjects.

1. The structure of parts connected with motion.
2. The structure of parts connected with digestion.
3. The Blood.
4. The Brain and Nerves.
5. The organs of Seeing and Hearing.
6. The Heart.
7. Generation.
8. Classification of Animals.,

Before we enter upon our analysis of the author's experiments and observations on these very different topics, we must beg leave to express our regret that he has not distinguished these inquiries, which are entirely and peculiarly his own, from those which were commenced, or suggested, by the late John Hunter, from whom he drew his first sources of information, and to whom he evidently owes much of that diligence in inquiry, and activity in research, which stamps his philosophical investigations, no less than his eminent professional career. We should also have been better pleased had he told us a little more of the discoveries of other anatomists and physiologists; such information, accompanied by proper references to authorities, would have added to the value and interest of the work before us, and we regret that our own time is too much

engaged to fill up this chasm, for which much labour and inquiry would be requisite. Upon the present occasion, therefore, we shall consider it our first duty and main object, to point out and discuss that which peculiarly belongs to Sir Everard Home, canvassing those views and opinions which are indisputably his own, and endeavouring to appreciate the originality and merit of his discoveries.

The statements respecting the powers of motion in vegetables, as well as many ingenious remarks upon the minute structure of muscle and its combination with elasticity, are, we presume, to be ascribed to Mr. Hunter, but the discovery of the structure of the left ventricle of the heart, is due to our author; at least he made it known in the year 1790, and it has never been claimed by any other anatomist, but acknowledged as correct, and taught in our Schools since that time: it is one of the most beautiful mechanical arrangements of the animal frame, and we cannot better communicate it to our readers than in the author's words.

"The muscular structure of the left ventricle of the human heart, detached from the other parts, is an oviform hollow muscle, but more pointed at its apex than the small end of a common egg; it is made up of two distinct sets of fibres lying upon each other. Those which compose the outer set have their origin around the root of the aorta, and in a spiral manner surround the ventricle to its point, where they terminate, after having made a close half turn."

"The fibres of the inner set are similar in their mode of surrounding the cavity, and in their termination, but they decussate the other set through their whole course, and the two sets are blended together where they terminate."

"In this muscle the fibres, by their spiral direction, are nearly one fourth part longer than the distance between their origin and termination, and the two sets acting in different directions, one half less contraction is necessary in each fibre than would otherwise have been the case; while the turn both sets make at the apex, fixes it and prevents lateral motion.

On the growth of shell and of bone there is nothing deserving of particular notice, but the formation of the intervertebral joints in fishes is curious as baffling artificial imitation. The illustration of this subject is taken from the *Squalus Maximus*, and it appears that each joint is a cavity filled with a fluid and forming a kind of ball and socket.

The subject of progressive motion, commenced in the first, is continued in the third volume, and is extremely interesting in its details and illustrations. The observations on the feet of the fly and other animals that walk against gravity, we believe are original and due to our author; they are illustrated by excellent engravings from Mr. Bauer's pencil, from which it appears that the animal is supported by a mechanism resembling cupping glasses. It is curious that the hind feet of that enormous animal the *Walrus*, are constructed upon

the same principle, to enable it to retain itself upon the slippery rocks which it climbs, and thus to prevent its falling backwards into the sea.

On the subject of digestion the author has taken infinite pains, both as regards the anatomy of the organs and the phenomena of the process; he deserves to be attentively consulted by all those who venture upon that difficult investigation, and when we find from his experiments that the horny part of the bird's gizzard coagulates milk in the same way as the gastric secretion, and thus appears to a superficial observer to possess the power of digesting, we cannot but smile at disputes which have arisen among physiologists of repute respecting that very important but recondite process, some maintaining, whilst others deny, that the division of the gastric nerves impedes or prevents that process altogether; while others tell us that by bringing their divided ends into contact, their functions are preserved and the operation continued. But how is all this ascertained? It is said by fair and convincing experiments. But how was the *digestion* demonstrated? Why, two rabbits were crammed with parsley previous to the experiment, and afterwards, upon examining the contents of the stomach, the parsley was digested in the one case, and unmixed, unaltered in the other.—We purposely abstain from any remarks upon the electrical part of this inquiry, but are inclined to ask, in which cavity of the rabbit's stomach the parsley was found? the stomach of that animal having two cavities, the one to prepare and macerate, the other to dissolve and digest.—We believe it was in the former—and in what state? Either upon the surface, above the other contents, unchanged, or more or less mixed with the other contents, and consequently, more or less acted upon by the juices with which they were previously imbued. Allowing, then, the greatest latitude for deduction, we ask what such experiment proves? It proves, supposing all preliminaries correct, that when the nerves are divided and their ends turned asunder and kept separated, that the muscular coats of both cavities of the stomach cease to act; but that when the divided ends of the nerves are left in contact, or again brought together, the *motion* of both portions of the stomach is renewed, and the contents blended together, this being the end for which each muscular action of the stomach is ordained. But all this is entirely independent of *digestion* properly so called—digestion is performed in the other cavity of the stomach.

The formation of the teeth is a very curious subject of inquiry, especially as relates to their variety of formation according to the different purposes for which they are intended in the different tribes of animals. The grinders of the Elephant furnish us with a very remarkable assemblage of three substances of different degrees of induration, which our author shews (Vol. III.) to correspond in texture to bone, ivory and enamel.

Concerning the stomach and its functions, many interesting matters

will be found in these volumes, particularly respecting the discovery of its lymphatics, and the branches of the *vas breve* in which the author considers them to terminate; his inquiries, too, respecting the structure and uses of the spleen, are new and elaborate, as well as the account of the intestinal canal. Our limits prevent us from entering at length into these curious discussions, for the details of which we must refer our readers to the work itself. Among them we were particularly struck with the proofs of the length of the intestines being proportionate to the difficulty of acquiring food and with those of the accumulation of fat in the lower bowels.

In the beginning of the third volume we find an entirely new analysis of the blood, founded chiefly upon Mr. Bauer's microscopical observations, from which it appears that the blood consists of red globules, from which the colouring matter, under certain circumstances, is detached; a smaller set of globules, which our author calls *lymph globules*, and an elastic transparent substance, soluble in water. Carbonic acid is also shewn to exist in the blood, and to be separable under certain circumstances during the act of coagulation. This latter circumstance, as connected with the vascularity of coagula, is one of the most important physiological discoveries of the present century.

The brain, the structure of which in the present day is a very favourite subject of investigation, has engaged no small share of Sir Everard's attention, and he has some new and very important remarks respecting it. In the first place, he adduces evidence in favour of its existing in a very different state and appearance in the living body, to that which its exhibits after death; in the former case, it has a gelatinous texture, and in the latter, appears to have undergone a species of coagulation. Upon this topic, also, we find in our author's work some novel and refined microscopical observations; We must admit that these investigations are very important; indeed the mechanical structure of the different parts of the body, though followed up with much perseverance by some of the older physiologists, has not of late received that attention which it merits; and we feel much indebted to Sir Everard Home for the inquiries which he and Mr. Bauer have instituted in this department of anatomy. But, however ingenious or plausible the investigations to which we allude may be, they will require much future observation, to confirm their accuracy, and to sanction the theories and views which our author has founded upon them.

But, secondly, there will be found in the volumes before us, the commencement of an inquiry into the functions of different parts of the brain, deduced from the effects of injuries upon them; this is, perhaps, the only satisfactory mode of arriving at legitimate conclusions in this abstruse department of physiology; and it is highly creditable to Sir Everard to have commenced a work which we most strongly advise should be followed up and extended as opening a

field, not only curious as a branch of human physiology, but of the highest importance as relating to the light which it may throw upon the treatment of injuries of the brain, and upon the general pathology of that organ.

With respect to the eye, after stopping to admire Mr. Bauer's beautiful drawings of its different parts, and the new muscle which the microscope alone could have brought within the reach of our observation, we cannot but assent to the use which the author has assigned to it. The discovery of lymphatics in the choroid coat of the bird's eye is also new, and may be urged in support of the opinions advanced respecting that set of vessels in the brain and stomach. For many years the existence of such vessels in those organs has been admitted; to have demonstrated them, certainly forms a very important step in the advancement of anatomical knowledge.

The use of the colouring matter called *nigrum pigmentum* in the eyes of quadrupeds, and of the marsupium of the bird, when applied generally to the skin of the negro, is probably the most curious discovery contained in these volumes, and one to which no other physiologist has laid claim. The explanation, too, of the manner in which the bird's eye is adapted to the vision of near and distant objects is extremely ingenious, and the result of much elaborate research.

The detection of the muscular structure of the *membrana tympani* in the organ of hearing of the elephant furnishes a strong argument in favour of the study of comparative anatomy, as having added to our anatomical knowledge of the human body, and showing that the charms of music can only reach their utmost extent in the ear that is highly cultivated.

The investigation of the series of structures employed in supplying the bodies of animals with blood, and of aërating that blood, considered as a distinct inquiry, is very beautiful, and the author must be allowed the merit of having handled his subject both with skill and judgment; it is a part of the work peculiarly deserving the study of the tyro in anatomy.

The pressure of other matter obliges us, for the present, to close this work, and to postpone, till the appearance of our next Number, the further account of its contents; we shall then, however, resume the subject more particularly in reference to the contents of the two recently published volumes, which, in point of accurate and splendid engravings, are even superior to their predecessors.

ART. XI. ASTRONOMICAL AND NAUTICAL COLLECTIONS.

No. XV.

i. *An Extension of the* INVERSE SERIES *for the computation of* REFRACTION, *together with a direct solution of the problem.*

CONSIDERING the acknowledged and increasing importance of the accurate determination of astronomical refractions, it may not be thought superfluous to attempt to confirm and extend the mode of computation, which has been adopted for the Table of Refractions printed in the Nautical Almanac, and at the same time to compare its results, in the most unfavourable case for its application, with those of the direct method, which, in that case only, are very readily obtained.

If r be the refraction, z the density, $= 1 - \chi$

y the pressure, x the distance from the centre,

u the perpendicular falling from the centre on the direction of the ray,

v the distance of this perpendicular from the point of refraction,

s the initial value of u, or x; we shall have (*Coll.* VI, VIII,)

$$\mathrm{d}r = \frac{\mathrm{d}u}{v} \qquad \mathrm{d}y = -mz\mathrm{d}x,$$

$$u = \frac{1+p}{1+pz}s = (1+p-pz)s = (1+p\chi)s,$$ and, p being a very small fraction,

$$v^2 = x^2 - u^2 = x^2 - s^2 - 2p\chi s, \quad \frac{\mathrm{d}y}{\mathrm{d}z} = \zeta$$

$$\frac{\mathrm{d}z}{\mathrm{d}r} = \frac{-v}{ps} \qquad \frac{\mathrm{d}y}{\mathrm{d}r} = \frac{-\zeta v}{ps}$$

$$\frac{\mathrm{d}x}{\mathrm{d}r} = \frac{\zeta v}{mpsz}.$$ We may then put, in order the better to observe the progress of the subsequent operations,

$$\frac{dv}{dr} = Z$$

$$\frac{d^2v}{dr^2} = * + Yv$$

$$\frac{d^3v}{dr^3} = Z' + * + Xv^2$$

$$\frac{d^4v}{dr^4} = * + Y'v + * + Vv^3$$

$$\frac{d^5v}{dr^5} = Z'' + * + X'v^2 + * + Uv^4$$

$$\frac{d^6v}{dr^6} = * + Y''v + * + V'v^3 + \dots$$

$$\frac{d^7v}{dr^7} = Z''' + * + X''v^2 + \dots$$

$$\frac{d^8v}{dr^8} = * + Y'''v + \dots$$

$$\frac{d^9v}{dr^9} = Z'''' + \dots$$

It will be convenient to denote the successive results of the differentiation of any quantity, Z, Y, X, with respect to y or z, which introduces a new power of v, by Z_1v, Z_2v^2, Y_1v, Y_2v^2, and so forth; we shall then have

$Z = Z \qquad Z' = YZ$

$Y = Z_1 \qquad Y' = 2XZ + Z'_1 = (2Y_1Z) + (Y_1Z + Y^2) = 3Y_1Z + Y^2$

$X = Y_1 \qquad X' = 3VZ + Y'_1 = (3Y_2Z) + (3Y_2Z + 3Y_1Y + 2Y_1Y)$

$V = X_1 = Y_2 \qquad = 6Y_2Z + 5Y_1Y$

$U = Y_3 \qquad V' = 4UZ + X'_1 = (4Y_3Z) + (6Y_3Z + 6Y_2Y) + (5Y_2Y + 5Y_1^2) = 10Y_3Z + 11Y_2Y + 5Y_1^2$

$Z'' = Y'Z = 3Y_1Z^2 + Y^2Z$

$Y'' = 2X'Z + Z''_1 = 12Y_2Z^2 + 10Y_1YZ + (3Y_2Z^2 + 6Y_1YZ) + 2Y_1YZ + Y^3) = 15Y_2Z^2 + 18Y_1YZ + Y^3$

$X'' = 3V'Z + Y''_1 = (30Y_3Z^2 + 33Y_2YZ + 15Y_1^2Z) + (15Y_3Z^2 + 30Y_2YZ) + (18Y_1^2Z + 18Y_2YZ + 18Y_1Y^2) + (3Y_1Y^2)$

$= 45Y_3Z^2 + 81Y_2YZ + 33Y_1^2Z + 21Y_1Y^2$

$$Z''' = Y''Z = 15Y_2Z^3 + 18Y_1YZ^2 + Y^3Z$$

$$\begin{aligned} Y''' = 2X''Z + Z'''_1 = &(90Y_3Z^3 + 162Y_2YZ^2 + 66Y_1^2Z^2 + 42Y_1Y^2Z) \\ &+ (15Y_3Z^3 + 45Y_2YZ^2) + (18Y_1^2Z^2 + 36Y_1Y^2Z \\ &\quad + 18Y_2YZ^2) \qquad + (3Y_1Y^2Z \\ &\qquad + Y^4) \\ = &105Y_3Z^3 + 225Y_2YZ^2 + 84Y_1^2Z^2 + 81Y_1Y^2Z \\ &+ Y^4 \end{aligned}$$

$$Z'''' = Y'''Z.$$

If we now select, from these general values of the coefficients, those which are concerned in the horizontal refraction, when $v = 0$, and $s = 1$, we shall have, instead of $ps = \frac{dv}{dr}\frac{r^2}{2} + \ldots$, putting $r' = \frac{r^2}{p}$,

$$1 = \frac{dv}{dr}\frac{r'}{2} + \frac{d^3v}{dr^3}p\frac{r'^2}{24} + \frac{d^5v}{dr^5}p^2\frac{r'^3}{720} + \ldots, \text{ or}$$

$$1 = \frac{Z}{2}r' + \frac{Z'}{24}pr'^2 + \frac{Z''}{720}p^2r'^3 + \frac{Z'''}{40320}p^3r'^4 + \frac{Z''''}{3628800}p^4r'^5$$

$+ \ldots$, in which we must substitute the values of $Z \cdots$, derived from the particular hypothesis respecting the constitution of the atmosphere that we may choose to adopt.

Example A. The simplest application, that can be made of this series, is to put, instead of Professor Leslie's hypothesis of $z^2 = y\,(n + z - nz^2)$, merely $z^2 = y$, whence $\zeta = \frac{dy}{dz} = 2z$, and $Z = \frac{2z}{mpsz} - s = \frac{2}{mps} - s$; consequently $dZ = 0$, and the series stops at the second term, assuming precisely the form which has been actually employed, as an approximation for determining the effect of a change of temperature. (*Coll.* VI.) To inquire what would be the physical conditions, that would be implied by this equation, would be to anticipate the contents of a very elaborate memoir, which is probably now in the press, and in which the author has deduced some very convenient and elegant expressions, when considered merely in a mathematical point of view, from a law of condensation which will scarcely

be admitted by natural philosophers in general, as applicable to the phenomena in their whole extent.

Example B. We may also obtain a finite inverse series, nearly resembling that of the Nautical Almanac, from the equation $y = .57 + .43z^3$, which is obviously impossible in nature, since it supposes a constant pressure after the density has vanished. A result, however, nearly identical, may be deduced from the supposition $y = 3.4z^2 - 4.1z^3 + 1.7z^4$, which implies an atmosphere terminating at the height of about 14 miles; although the series thus obtained would extend to a fifth term, instead of ending at the fourth, but without producing any material difference in the result. Considering, indeed, the analogy between logarithms and high powers, it is not improbable that the true value of y might be very correctly expressed by a series of this form, however complicated it might appear at first sight. The value of x and the height $h = 20900000\ (x - 1)$, in feet, might be found from the fluxion $\mathrm{d}x = \frac{-\mathrm{d}y}{mz} = 6.8\mathrm{d}z - 12.3z\mathrm{d}z + 6.8\,z^2\mathrm{d}z$, and $x - 1 = \frac{1}{m}(-6.8z + 6.15z^2 - 2.27z^3 + 2.92)$, or $h = 27300\ (2.92 - 6.8z + 6.15z^2 - 2.27z^3)$; which becomes 21300, when the density z is reduced to $\frac{1}{2}$; and the pressure $y = .444$.

Example C. A. As the most unfavourable specimen of the application of this method, we may take the case of an equable temperature, at the horizon: and first suppose, with Laplace, that $m = 798$, and $\frac{1}{p} = 3403$, so that $\frac{1}{mp} = 4.2624$, $Z = \frac{\zeta}{mp} - 1 = 3.2624$, since z is here $= y$, and $\zeta = 1$; $Y = \frac{1}{mp} \cdot \frac{1}{p} = \frac{4.2624}{p}$, $Y_1 = \frac{2}{p}\ Y$, $Y_2 = \frac{3}{p} Y_1$, and $Y_3 = \frac{4}{p} Y_2$. Hence we have $YZ = \frac{13.9056}{p} = Z'$, and the equation becomes $1 = 1.6312r' + .5794r'^2 + .4603r'^3 + .5093r'^4$

$+ .6517r'^5 + \ldots$ Now the value of r' cannot be very accurately obtained from these coefficients, without a liberal employment of the method of logarithmic differences, finding the results derived by it from the first three, the middle three, and the last three terms, and comparing these with each other; and in this manner it seems natural to suppose that we might easily come within about $\frac{1}{500}$ of the truth. (*Coll.* VIII.) The best inference of this kind, however, that has been obtained, was $r = 40'\ 15''$, which is too much by about $\frac{1}{130}$.

If still greater accuracy were required, we might compute a greater number of the coefficients of the series, or we might separate the computation into two or more parts: but it would be a little troublesome to adapt the new values of Z, and its derivatives, either to the diminished magnitude of the density z, or to a value of p, diminished in the same proportion; so that if the actual density at the time in question were called unity, the refractive density might still be truly represented by $1 + p$; observing also to make the remaining portion Δz also equal to unity: and in this case the values of Z, and of its powers, only would require to be changed in the subsequent computation. This operation has been somewhat more negligently performed in the Astronomical Collections; but its object then was merely to show the convergence of the series, and that object was obtained.

B. With the values $m = 766$, $p = \frac{1}{3540}$, and $\frac{1}{mp} = 4.621$, we obtain $Z = 3.621$, $Y = \frac{4.621}{p}$, $Z' = YZ = 17.190$, $Z'' = \frac{6}{p} YZ^2 + Y^2 Z = \frac{452.916}{p^2}$, $Z'' = \frac{31290}{p^2}$, and $Z'''' = \frac{3714095}{p^4}$; and for the equation $1 = \frac{Z}{2} r' + \frac{Z''}{24} pr'^2 + \ldots$, we have $1 = 1.8105r' + .7162r'^2 + .6290r'^3 + .7760r'^4 + 1.0231r'^5 + \ldots$; and if we make $r' = 44$, we shall have the

true sum 1.0460; if $r' = .43$, 1:0218, whence $r' = 4210$, and r appears to be 37′ 29″.

But if we wish to supply any real or imaginary deficiency of the inverse series, we may easily revert to a modification of the original solution of Taylor*, who first applied to the problem of atmospherical refraction his very useful theorem for "integration by parts," as the process is sometimes now called, that is, $\int Z\mathrm{d}Y = \frac{\mathrm{d}Y}{\mathrm{d}X}\int Z\mathrm{d}X - \mathrm{d}\frac{\mathrm{d}Y}{\mathrm{d}X^2}\int^2 Z\mathrm{d}X^2 + \ldots$; and not $\int Y\mathrm{d}Z = \ldots$, as it has been inaccurately copied in the Article Fluents of the Supplement of the Encyclopædia Britannica, n. 5, 546. Taking the fundamental equation for the refraction, $\mathrm{d}r = \frac{\mathrm{d}z}{v}$, and making first $Z = \frac{1}{v}$, $\mathrm{d}X = v\mathrm{d}v$, and $\mathrm{d}Y = \mathrm{d}z$, we have for $\int Z\mathrm{d}x, \int^2 Z\mathrm{d}x^2, \ldots, v, \frac{1}{3}v^3, \frac{1}{3.5}v^5, \ldots$, and for $\frac{\mathrm{d}Y}{\mathrm{d}X}, \ldots, \frac{\mathrm{d}z}{v\mathrm{d}v}, \mathrm{d}\frac{\mathrm{d}z}{v\mathrm{d}v} : v\mathrm{d}v, \ldots$; or secondly, making $\frac{\mathrm{d}z}{v} = \mathrm{d}\frac{z}{v} + \frac{z\mathrm{d}v}{vv}$, we have $\int\frac{\mathrm{d}z}{v} = \frac{z}{v} + \int\frac{z\mathrm{d}v}{vv}$, in which making $\mathrm{d}X$ again $= v\mathrm{d}v$, and $Z = z$, $\mathrm{d}Y$ being $= \frac{\mathrm{d}v}{vv}$, we have $\int\frac{\mathrm{d}z}{v} = \frac{z}{v} + \frac{1}{v^3}\int zv\mathrm{d}v + \frac{3}{v^5}\int^2 zv\mathrm{d}v . v\mathrm{d}v + \frac{3.5}{v^7}\ldots$, Now in all cases $v^2 = x^2 - u^2$, and $v\mathrm{d}v = x\mathrm{d}x - u\mathrm{d}u = x\mathrm{d}x + psu\mathrm{d}z$, and since $\mathrm{d}x = \frac{-\mathrm{d}y}{mz} = \frac{-\zeta\mathrm{d}z}{mz}$, we have $\frac{v\mathrm{d}v}{\mathrm{d}z} = \frac{-x\zeta}{mz} + psu = \frac{mpsuz - x\zeta}{mz}$, and $\frac{\mathrm{d}z}{v\mathrm{d}v} = \frac{mz}{mpsuz - x\zeta}$, whence $r = \int\frac{\mathrm{d}z}{v} = \frac{vmz}{mpsuz - x\zeta} - \frac{v^3}{3}\mathrm{d}\frac{vmz}{mpsuz - x\zeta} . \frac{1}{\mathrm{d}z} . \frac{mz}{mpsuz - x\zeta} + \ldots$; and from one or the other of the series thus obtained, we may always compute the value of r, taking the fluents from $z = 1$ to $z = 0$. But at the horizon, it will be

easier to employ the particular fluent ${}^1\!\int_0 \frac{dz}{\sqrt{hl\frac{1}{z}}} = \sqrt{\pi}$, discovered by Euler, and still more elegantly demonstrated by Laplace, in the form ${}^{-\infty}\!\int_{\infty} e^{-xx}\,dx = \sqrt{\pi}$: and the application of this proposition leads us to the integration of several fluents, which may be thus enumerated*:

A. $${}^1\!\int_0 \frac{dz}{\sqrt{hl\frac{1}{z}}} = \sqrt{\pi} = \sqrt{3.141592}$$

B. $${}^1\!\int_0 \frac{z^n dz}{\sqrt{hl\frac{1}{z}}} = {}^1\!\int_0 \frac{\sqrt{(n+1)}}{n+1}\cdot\frac{dy}{\sqrt{hl\frac{1}{y}}} = \sqrt{\frac{\pi}{n+1}},$$ by putting $y = z^{n+1}$.

C. $$\int \frac{z^n dz}{hl^m\frac{1}{z}} = \frac{1}{m-1}\cdot\frac{z^{n+1}}{hl^m\frac{1}{z}} - \frac{n+1}{m-1}\int\frac{z^n dz}{hl^{m-1}\frac{1}{z}}$$

i. $${}^1\!\int_0 \frac{dz}{hl^{\frac{3}{2}}\frac{1}{z}} = 2\frac{z}{hl^{\frac{1}{2}}\frac{1}{z}} - 2\sqrt{\pi};\ {}^1\!\int_0 \frac{dz}{hl^{\frac{5}{2}}\frac{1}{z}} = \frac{2}{3}\frac{z}{hl^{\frac{3}{2}}\frac{1}{z}} - \frac{4}{3}\frac{z}{hl^{\frac{1}{2}}\frac{1}{z}} + \frac{4}{3}\sqrt{\pi}$$

ii. $${}^1\!\int_0 \frac{zdz}{\sqrt{hl\frac{1}{z}}} = \sqrt{\frac{\pi}{2}};\ {}^1\!\int_0 \frac{zdz}{hl^{\frac{3}{2}}\frac{1}{z}} = 2\frac{zz}{hl^{\frac{1}{2}}\frac{1}{z}} - 4\sqrt{\frac{\pi}{2}};\ {}^1\!\int_0 \frac{zdz}{hl^{\frac{5}{2}}\frac{1}{z}} = \frac{2}{3}\frac{zz}{hl^{\frac{3}{2}}\frac{1}{z}} - \frac{8}{3}\frac{zz}{hl^{\frac{1}{2}}\frac{1}{z}} + \frac{16}{3}\sqrt{\frac{\pi}{2}}$$

iii. $${}^1\!\int_0 \frac{(1-z)dz}{hl^{\frac{3}{2}}\frac{1}{z}} = {}^1\!\int_0 \frac{\chi dz}{hl^{\frac{3}{2}}\frac{1}{z}} = \left(\frac{4}{\sqrt{2}} - 2\right)\sqrt{\pi} = (2(\sqrt{2}-1)\sqrt{\pi} = .828427\sqrt{\pi}$$

iv. $${}^1\!\int_0 \frac{zzdz}{\sqrt{hl\frac{1}{z}}} = \sqrt{\frac{\pi}{3}};\ {}^1\!\int_0 \frac{zzdz}{hl^{\frac{3}{2}}\frac{1}{z}} = 2\frac{z^3}{hl^{\frac{1}{2}}\frac{1}{z}} -$$

$$6\sqrt{\frac{\pi}{3}};\ {}^{1}\!\!\int_0 \frac{zz\mathrm{d}z}{\mathrm{hl}^{\frac{5}{2}}\frac{1}{z}} = \frac{2}{3}\,\frac{z^3}{\mathrm{hl}^{\frac{3}{2}}\frac{1}{z}} - 4\,\frac{z^3}{\mathrm{hl}^{\frac{3}{2}}\frac{1}{z}}$$

$$+ 12\sqrt{\frac{\pi}{3}}.$$

v. $${}^{1}\!\!\int_0 \frac{(1-z)^2\mathrm{d}z}{\mathrm{hl}^{\frac{5}{2}}\frac{1}{z}} = \left(\frac{-4}{3} + \frac{2.16}{\sqrt{2.3}} - \frac{36}{\sqrt{3.3}}\right)$$

$$\sqrt{\pi} = .719064\sqrt{\pi}.$$

vi. $${}^{1}\!\!\int_0 \frac{(1-z)^3\mathrm{d}z}{hl^{\frac{7}{2}}\frac{1}{z}} = .642767\sqrt{\pi}.$$

Now the value of $v = \sqrt{(x^2 - s^2 - 2p\chi s)}$, becomes here $\sqrt{(x^2 - 1 - 2p\chi)}$; and since $x - 1 = \int \mathrm{d}x = -\int \frac{\mathrm{d}y}{mz}$, making $\int \mathrm{d}x = \varkappa$, or $x^2 = (\varkappa + 1)^2$, we have $x^2 - 1 = \varkappa^2 + 2\varkappa$; but the actual extent of the atmosphere is so limited, that we may neglect $\varkappa^2$, in comparison with $2\varkappa$, without sensible error, and make $x^2 - 1 = 2\varkappa$, and $\mathrm{d}r = \frac{-p\mathrm{d}z}{\sqrt{(2\varkappa - 2p\chi)}} = \frac{-p}{\sqrt{2}}.\frac{\mathrm{d}z}{\sqrt{\varkappa}}$ $\left(1 - \frac{p\chi}{\varkappa}\right)^{-\frac{1}{2}} = \frac{-p}{\sqrt{2}} \cdot \frac{\mathrm{d}z}{\sqrt{\varkappa}}\ (1 + \frac{1}{2}\,\frac{p\chi}{\varkappa} + \frac{3}{8}$ $\frac{p^2\chi^2}{\varkappa^2} + \frac{5}{16}\,\frac{p^3\chi^3}{\varkappa^3} + \ldots) = \frac{-p}{\sqrt{2}}\left(\frac{\mathrm{d}z}{\sqrt{\varkappa}} + \frac{1}{2}\,\frac{p\chi\mathrm{d}z}{\varkappa^{\frac{3}{2}}} + \frac{3}{8}\right.$ $\left.\frac{p^2\chi^2\mathrm{d}z}{\varkappa^{\frac{5}{2}}} + \ldots\right)$. This expression is applicable to every hypothesis by which the relation of x to z can be expressed; and in the case of a uniform temperature, since $\mathrm{d}y = -mz\mathrm{d}x = \mathrm{d}z$, and $\mathrm{d}x = \frac{-\mathrm{d}z}{mz}$, we have $\varkappa = -\int \frac{\mathrm{d}z}{mz} = \frac{1}{m}\,\mathrm{hl}\,\frac{1}{z}$, and

$$\mathrm{d}r = -p\sqrt{\frac{m}{2}}\left(\frac{\mathrm{d}z}{\sqrt{\mathrm{hl}\frac{1}{z}}} + \frac{1}{2}\,mp\,\frac{\chi\mathrm{d}z}{\mathrm{hl}^{\frac{3}{2}}\frac{1}{z}} + \frac{3}{8}\,m^2p^2\right.$$

$$\left.\frac{\chi^2\mathrm{d}z}{\mathrm{hl}^{\frac{5}{2}}\frac{1}{z}} + \frac{5}{16}\,m^3p^3\,\frac{\chi^3\mathrm{d}z}{\mathrm{hl}^{\frac{5}{2}}\frac{1}{z}} + \ldots\right).$$ Then, by the integration

already explained, ${}^{\prime}\!\!\int_0 \mathrm{d}r = -p \sqrt{\frac{m\pi}{2}}\,(1 + .414214\,mp$ $+ .269649\,m^2p^2 + .200865\,m^3p^3 + \ldots)$ or, taking $\frac{1}{p} =$ 3403, and $m = 798$, $r = .010423\cdot(1 + .097133 + .014830$ $+ .00259 + [.0005]) = .010423 \times 1.1151 = 39'\,57''$; so that the former result was too great by $18''$: and if we make $\frac{1}{p} = 3540$, and $m = 766$, we find $r = .0097988\,(1 + .08963$ $+ .01263 + .00203 + [.00040]) = .0097988\,(1.1047) =$ $.010825 = 37'\,13''$, or $16''$ less than the former computation made it; the difference, which before came out $2'\,46''$, being now found, a little more accurately, $2'\,44''$.

The relation between x and z may be computed from the hypothesis of an equable variation of temperature in ascending, according to the statement expressed by the equation $z = y$ $(1 + tx - t)$ (*Coll.* VI. 7. D), or $z = yw$, whence

$$\mathrm{d}y = \frac{\mathrm{d}z}{w} - \frac{z\mathrm{d}w}{ww}, \qquad \frac{\mathrm{d}z}{z} = \frac{\mathrm{d}w}{w} + \frac{w\mathrm{d}y}{z}, \text{ but}$$

$$\mathrm{d}y = -mz\mathrm{d}x, \text{ and} \qquad \frac{\mathrm{d}z}{z} = \frac{\mathrm{d}w}{w} - mw\mathrm{d}x; \text{ consequently}$$

$\mathrm{hl}z = \mathrm{hl}w - m\!\int\! w\mathrm{d}x$, and $z = we^{-m\int w\mathrm{d}x} = (1 + tx - t)$ $e^{-m(x+\frac{1}{2}txx-tx)}$; and from this expression we may find the density z corresponding to any height x, upon the supposition that the bulk of a given quantity of air varies *proportionally* with a uniform variation of temperature, and not *uniformly*, as the experiments of Schmidt and Gay Lussac induced them to infer with respect to ordinary temperatures. (See Nat. Philos. Vol. II, p. 393.) If we computed the horizontal refraction from this equation by means of the series beginning with $\frac{\mathrm{d}z}{\mathrm{z}}$, we should have to substitute, for $\mathrm{d}z$, $(1 + tx - t)\,e^{-m(x+\frac{1}{2}txx-tx)}$ $(-m\mathrm{d}x - mtx\mathrm{d}x)$ and for z, $x - 1$.

Besides the equation $y = az^2 + bz^3 + cz^4 + \ldots$, there may probably be many others, not far from the true constitution of the atmosphere, which would afford finite expressions for the

refraction; thus, if $y = z^{\frac{3}{2}}$, we have $dx = \frac{-dy}{mz} = -\frac{3}{2}\frac{\sqrt{z}dz}{mz}$ and $s = x - 1 = \frac{3}{m}(1 - \sqrt{z})$, whence $dr = \frac{-pdz}{\sqrt{(2s - 2p\chi)}}$

$$= \frac{-pdz}{\sqrt{\left(\frac{6}{m} - \frac{6}{m}\sqrt{z} - 1 + z\right)}}, \text{ or, if } \sqrt{z} = \psi,$$

$$\frac{-2p\psi d\psi}{\sqrt{\left(\frac{6}{m} - 1 - \frac{6}{m}\psi + \psi^2\right)}},$$ and the fluxion assumes the form $\frac{xdx}{\sqrt{(a+bx+cx^2)}}$, Article FLUENTS, n. 259; and there is little doubt that such a hypothesis, if advanced with sufficient pomp and ceremony, would be allowed to represent the constitution of the lower parts of the atmosphere, which are principally concerned in the refraction, much better than that of Bessel, though, perhaps, not quite so accurately as they might be represented by a more appropriate, though less convenient, exponent.

London, 6th Aug. 1823.

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ii. *Catalogue of the* ORBITS *of all the* COMETS *hitherto computed.* By Dr. OLBERS and Professor SCHUMACHER. Astr. Abh. I.

" This Table originated from a request of the Editor of the Astronomical and Nautical Collections, that Dr. Olbers would have the kindness to furnish him with any additional materials that could be incorporated with the former Table, as it stood at the end of the Essay on Comets. He was so good as to send his remarks to Professor Schumacher, who introduced them, in their proper places, together with some corrections and additions of his own, into Delambre's Table."

[The remainder, n. 71..125, in our next Number.]

N.	Delambre.	Date.	Passage of the Perihelium in Parisian mean time. O. S.	Longitude of the Perihelium.	Longitude of the ascending node.	Angle between the Perihelium and the node.	Inclination.	Distance in the Perihelium.	Log. Dist. Perihelium.	Log. mean motion.	Eccentricity.	Direction.	Name of the Computer.
			h ' "	s ° ' "	s ° ' "	s ° ' "	° ' "						
1	1	240	Nov.10 0 0 0	9 1 0 0	6 9 0 0	2 22 0 0	44 0 0	0.371000	9.570000	0.605000		D	Burckhardt
2	2	539	Oct. 20 15 30 0	10 13 30 0	{1, 7} 28	{8, 2} 15 30 0	10 0 0	0.341200	9.533070	0.660523		D	idem
3	3	565	July 9 0 0 0	2 28 0 0	5 8 0 0	2 10 0 0	62 0 0	0.719000	9.856860	0.174840		R	idem
			14 12 0 0	2 20 0 0	5 9 30 0	2 19 30 0	59 0 0	0.832000	9.920000	0.080130		R	idem
4	4	837	Mar. 1 0 0 0	9 19 3 0	6 26 33 0	9 7 30 0	10 or 12	0.580000	9.763428	0.314986		R	Pingré
5	5	989	Sep. 12 0 0 0	8 24 0 0	2 24 0 0	6 0 0 0	17 0 0	0.568000	9.754600	0.328200		R	Burckhardt
6	6	1066	May 30 or 31	4 0 0 0	7 20 0 0	3 20 0 0	70 or 80	0.340000	9.530000	0.665		R	Pingré
7	7	1097	Sep. 31 9 . 0 0	11 2 30 0	6 27 30 0	4 5 0 0	73 30 0	0.738500	9.868320	0.157648		D	Burckhardt
8	8	1231	Jan. 30 7. 22 0	4 14 48 0	0 13 30 0	4 1 18 0	6 5 0	0.947760	9.976608	9.935081		D	Pingré
9	9	1264	July 6 8 0 0	9 21 0 0	5 19 0 0	4 2 0 0	36 30 0	0.445000	9.648360	0.487588		D	Dunthorn
			16 0 0 0	9 2 30 0	5 25 30 0	3 7 0 0	30 25 0	0.430000	9.633469	0.509924		D	Pingré
			17 6 10 0	9 5 45 0	5 28 45 0	3 7 0 0	30 25 0	0.410810	9.613640	0.539668		D	idem
10	10	1299	Mar.31 7 38 0	0 3 20 0	3 17 8 0	3 13 48 0	68 57 . 0	0.317930	9.502330	0.706633		D	idem
11	11	1301	Sep. Beg.	6 0 0 0	2 0 0 0	4 0 0 0	80	0.330000	9.518500	0.68236		R	idem
	12	1301	Oct. 22 0 0 0	9 0 0 0	0 15 0 0	3 15 0 0	70	0.457000	9.660000	0.47		D	Burckhardt
12	13	1337	June 2 6 35 0	1 7 59 0	2 24 21 0	1 16 22 0	32 11 0	0.406660	9.609236	0.546274		R	Pingré
			1 0 40 0	0 20 0 0	2 · 6 22 0	1 16 22 0	32 11 0	0.644520	9.809210	0.246268		R	Halley
13	14	1351	Nov.26 12. 0 0	2 9 0 0	uncertain	uncertain	uncertain	1.000000	0.000000	9.96013		R	Pingré
14	15	1362	Mar.11 5 0 0	7 9 0 0	8 9 0 0	1 0 0 0	21 0 0	0.455800	9.658750	0.47202		D	Burckhardt
			2 8 0 0	7 17 0 0	7 27 0 0	0 10 0 0	32 0 0	0.170000	9.672140	0.47073		R	idem
15	16	1456	June 8 22 10 0	10 1 0 0	1 18 30 0	3 17 30 0	17 56 0	0.585520	9.767540	0.308818		R	idem
16	17	1472	Feb. 28 22 33 0	1 15 33 30	9 11 46 20	7 26 12 50	5 20 0	0.542730	9.734584	0.358252		R	Pingré
(15)	16	1531	Aug.24 21 28 0	10 1 39 0	1 19 25 0	3 17 46 0	17 56 0	0.567000	9.753583	0.329754		R	Halley
			25 19 10 0	10 1 12 0	1 15 30 0	3 14 18 0	17 0 0	0.57093	9.76338	0.315058	0.967373	R	idem
17	18	1532	Oct. 19 22 21 0	3 21 7 0	2 20 27 0	1 0 40 0	32 36 0	0.509100	9.706803	0.399924		R	idem
			19 15 2 0	4 15 44 0	3 29 8 0	0 16 36 0	42 27 0	0.612550	9.787141	0.279416		D	idem
			18 8 8 0	3 21 48 0	2 27 23 0	0 24 25 0	32 36. 0	0.519220	9.715351	0.387101		D	Méchain
18	19	1533	June16 19 40 0	3 14 12 0	4 5 44 0	0 21 32 0	35 49 0	0.202800	9.307068	0.999526		D	Olbers
			14 21 20 52	7 7 40 0	9 29 19 0	9 8 21 0	28 14 0	0.326860	9.514362	0.688585		R	Douwes
(9)	9	1556	Apr.21 20 13 0	9 8 50 0	5 25 42 0	3 13 8 0	32 6 30	0 463900	9.666424	0.460492		D	Olbers
19		1558	Aug.10 13 0 0	10 29 49 0	11 2 36 0	0 2 47 0	73 49 0	0.5773	9.76140	0.31803		D	Halley
												R	Olbers

N.	Delambre	Date.	Passage of the Perihelium in Parisian mean time.	Longitude of the Perihelium.	Longitude of the ascending node.	Angle between the Perihelium and the node.	Inclination.	Distance in the Perihelium.	Log. Dist. Perihelium.	Log. mean motion.	Eccentricity.	Direction.	Name of the Computer.
			h ′ ″	s ° ′ ″	s ° ′ ″	s ° ′ ″	° ′ ″						
20	20	1577	Oct. 26 18 55 0	4 9 22 0	0 25 52 0	8 16 30 0	74 32 45	0.183420	9.263447	1.064958		R	Halley
21	21	1580	Nov. 28 15 10 0	3 19 5 50	0 18 57 20	3 0 8 30	64 40 0	0.596280	9.775450	0.296953		D	Halley
			28 13 54 0	3 19 11 55	0 19 7 37	3 0 4 18	64 51 50	0.595530	9.774903	0.297774		D	Pingré
22	22	1582	May 6 16 9 0	8 5 23 10	7 21 7 20	11 15 44 10	61 27 50	0.225695	9.353522	0.929845		R	idem
			7 8 30 OS	9 11 26 45	7 4 42 35	9 23 15 50	59 29 5	0.040066	8.602754	2.055997		R	idem
23	23	1585	Oct. 7 19 30 NS	0 8 51 0	1 7 42 30	11 1 8 30	6 4 0	1.093580	0.038850	9.901853		D	Halley
24	24	1590	Feb. 8 3 55 0	7 6 54 30	5 15 30 40	10 8 36 10	29 40 40	0.576610	9.760882	0.318805		R	idem
25	25	1593	July 18 13 48 0	5 26 19 0	5 11 15 0	0 12 4 0	87 58 0	0.089110	8.949940	1.535218		D	La Caille
26	26	1596	Aug. 10 20 5 0	7 18 16 0	10 12 12 30	2 23 56 30	55 12	0.512930	9.710058	0.395041		R	Halley
			8 15.43 0	7 28 30 50	10 15 36 50	2 17 6 0	52 9 45	0.549124	9.739308	0.350266		R	Pingré
(15)	16	1607	Oct. 26 4 0 0	10 2 16 0	1 20 21 0	3 18 5 0	17 2 0	0.586800	9.768490	0.307393		R	Halley
			26 17 20 19	10 1 38 10	1 18 40 28	3 17 2 18	17 12 17	0.587974	9.769358	0.306091	0.9670888	R	Bessel
			26 21 54 0	10 1 3 40	1 17 48 40	3 16 45 0	17 20 0	0.58507	9.767208	0.309316	9.967391	R	Halley
27	27	1618	Aug. 17 3 12 0	10 18 20 0	9 23 25 0	0 24 55 0	21 28	0.512980	9.710100	0.394978		D	Pingré
28	28	1618	Nov. 8 12 33 0	0 2 14 0	2 16 1 0	9 16 13 0	37 34	0.379750	9.579498	0.590881		D	Halley
			8 8 34 15	0 3 5 21	2 15 41 10	9 17 21 11	37 11 31	0.389541	9.590556	0.574294		D	Bessel
29	29	1652	Nov. 12 15 50 0	0 28 18 40	2 28 10 0	10 0 8 40	79 28 0	0.847500	9.928140	0.067918		D	Halley
30	18	1661	Jan. 26 23 50 0	3 25 58 40	2 22 30 30	1 3 28 10	32 35 50	0.4485100	9.651772	0.482470		D	Halley
			26 21 18 0	3 25 16 8	2 21 54 0	1 3 22 8	33 0 55	0.4427220	9.646131	0.490932		D	Méchain
31	30	1664	Dec. 4 12 2 0	4 10 41 25	2 21 13 55	10 10 32 30	21 18 40	1.0257550	0.011041	9.943562		R	Halley
32	31	1665	Apr. 24 5 25 10	2 11 54 30	7 18 2 0	5 6 7 30	76 5 0	0.1064900	9.027309	1.419164		R	idem
33	32	1672	Mar. 1 8 47 0	1 16 59 30	9 27 30 30	3 19 29 0	83 22 10	0.6973900	9.843476	0.194914		D	idem
34	33	1677	May 6 0 47 10	4 17 37 5	7 26 49 10	3 9 12 5	79 3 15	0.2805900	9.448072	0.788020		R	idem
35	34	1678	Aug. 26 14 13 0	10 27 46 0	5 11 40 0	5 16 6 0	3 4 20	1.2380200	0.092727	9.821037		D	Douwes
36	35	1680	Dec. 18 0 15 0	8 22 39 30	9 2 2 0	11 20 37 30	60 56 0	0.0061250	7.787106	3.279469		D	Halley
			17 23 19 0	8 22 44 25	9 2 2 0	11 20 42 25	61 6 48	0.0061750	7.790637	3.274701	0.9999107	D	idem
			17 20 48 0	8 23 26 48	9 2 59 9	11 20 27 39	58 30 50	0.0065645	7.817202	3.234325	0.9997866	D	Euler
			18 0 4 0	8 23 43 0	9 1 53 0	11 21 50 0	61 20 20	0.0059200	7.7723	3.301678		D	Newton
			18 0 10 22	8 22 40 10	9 1 57 13	11 20 42 57	61 22 55	0.0060297	7.780295	3.289686	0.9999898	D	Pingré
			17 23 59 58	8 22 49 19	9 2 9 33	11 20 39 46	60 38 37	0.00623391	7.7947604	3.2679877		D	Encke
			17 23 55 30	8 22 49 5	9 2 9 29	11 20 39 36	60 40 16	0.00622236	7.7939551	3.2692957	0.999985117	D	idem
(15)	16	1682	Sep. 14 7 49 0	10 2 52 45	1 21 16 30	3 18 23 45	16 56 0	0.583280	9.765877	0.311312		R	Halley

N.	Delambre	Date.	Passage of the Perihelium in Parisian mean time. N. S.	Longitude of the Perihelium.	Longitude of the ascending node.	Angle between the Perihelium and the node.	Inclination.	Distance in the Perihelium.	Log. Dist. Perihelium.	Log. mean motion.	Eccentricity.	Direction.	Name of the Computer.
			h ′ ″	s ° ′ ″	s ° ′ ″	s ° ′ ″	° ′ ″						
			Sep. 14 21 31 0	10 1 36 0	1 20 48 0	3 19 12 0	17 42 0	0.582500	9.765296	0.312184	0.967392	R	Halley
			14 17 45 36	10 2 3 45	1 21 7 10	3 19 3 25	17 48 0	0.582428	9.7650424	0.3125647	0.9676763	R	Burckhardt
37	36	1682	July 13 2 59 0	2 25 29 30	5 23 23 0	2 27 53 30	83 11 0	0.560200	9.748343	0.337614		R	Halley
38	37	1684	June 8 10 26 0	7 28 52 0	8 28 15 0	11 0 37 0	65 48 40	0.9601500	9.982339	9.986620		D	idem
39	38	1686	Sep. 16 14 43 0	2 17 0 30	11 20 34 40	2 26 25 50	31 21 40	0.3250000	9.511883	0.692304		D	idem
40	39	1689	Dec. 1 15 5 0	8 23 44 45	10 23 45 20	2 0 0 35	69 17 0	0.0168890	8.227604	2.618722		R	Pingré
41	40	1695	Nov. 17 — — —	2 6 0 0	7 6 0 0	7 0 0 0	22 0 0	0.843480	9.9261	0.07773		D	Burckhardt
42	41	1698	Oct. 18 17 7 0	9 0 51 15	8 27 44 15	11 26 53 0	11 46 0	0.691290	9.839660	0.200638		R	Halley
43	42	1699	Jan. 13 8 32 0	7 2 31 6	10 21 45 35	3 19 14 29	69 20 0	0.744000	9.871570	0.152773		R	La Caille
44	43	1701	Oct. 17 22 0 0	4 13 41 0	9 28 41 0	5 15° 0 0	41 39 0	0.592630	9.772784	0.300953		R	Burckhardt
45	44	1702	Mar. 13 14 22 0	4 18 41 3	6 9 25 15	10 9 15 48	4 30 0	0.645900	9.810165	0.244881		D	La Caille
			13 14 42 43	4 18 46 34	6 8 59 10	10 9 47 24	4 24 44	0.646830	9.81079	0.243943		D	Burckhardt
46	45	1706	Jan. 30 4 32 0	2 12 29 10	0 13 11 40	1 29 17 30	55 14 10	0.425810	9.629218	0.516301		D	La Caille
			30 5 6 0	2 12 36 25	0 13 11 23	1 29 25 2	55 14 5	0.426865	9.630291	0.514692		D	Struyck
47	46	1707	Dec. 11 23 39 0	2 19 54 56	1 22 46 35	0 27 8 21	88 36 0	0.85974	9.934368	0.058576		D	La Caille
			11 23 52 47	2 19 58 9	1 22 50 29	0 27 7 40	88 87 40	0.85904	9.934013	0.059109		D	Struyck
			. . . . . .	2 17 4 0	1 22 8 0	0 24 56 0	88 50 0	0.86350	9.936262	0.055735		D	Houttuyn
48	47	1718	Jan. 14 23 48 0	4 1 30 0	4 8 43 0	0 7 13 0	30 20 0	1.02655	0.011380	9.943058		R	La Caille
			15 1 24 36	4 1 26 36	4 7 55 30	0 6 28 54	31 12 53	1.02565	0.010999	9.943629		R	Douwes
			15 7 48 0	4 1 3 40	4 8 21 0	0 7 17 20	30 48 30	1.02743	0.011753	9.942499		R	Whiston
49	48	1723	Sep. 27 16 20 0	1 12 52 20	0 14 16 0	11 1 23 40	49 59 0	0.99865	9.999414	9.961007		R	Bradley
			27 16 10 0	1 12 15 20	0 14 14 6	11 1 58 46	49 59 0	0.96980	9.986682	9.980105		R	Struyck
			23 20 38 24	1 12 35 12	0 14 10 2	11 1 34 50	49 55 25	0.999707	9.9998700	9.9603233	1.019956	R	Burckhardt
50	49	1729	June 23 6 45 22	10 22 16 54	10 10 35 15	0 11 41 39	77 1 58	4.06980	0.609573	9.015769		D	Douwes
			25 11 16 0	10 22 40 0	10 10 32 37	0 12 7 23	76 58 4	4.26140	0.629552	9.015800		D	La Caille
			22 23 54 29	10 27 21 38	10 10 16 46	0 17 4 52	76 42 45	4.16927	0.620060	9.030038		D	Maraldi
			May 22 10 52 14	10 16 26 48	10 10 51 43	0 5 35 5	77 18 54	3.91927	0.596517	9.065353		D	Kies
			June 25 9 21 0	10 22 37 3	10 10 32 55	0 12 4 8	77 1 0	4.08165	0.610835	9.043876		D	Delisle
			13 6 29 0	10 20 31 22	10 10 38 0	0 9 53 22	77 5 18	4.043496	0.6067570	9.0501878	1.0050334	D	Burckhardt
			12 4 19 0	10 20 27 36	10 10 38 0	0 9 49 36	77 5 18	4.0431	0.6067145	9.0502515		D	idem
51	50	1737	Jan. 30 8 30 0	10 25 55 0	7 16 22 0	3 9 33 0	18 20 45	0.22282	9.347960	0.938188		D	Bradley

N.	Delambre.	Date.	Passage of the Perihelium in Parisian mean time.	Longitude of the Perihelium.	Longitude of the ascending node.	Angle between the Perihelium and the node.	Inclination.	Distance in the Perihelium.	Log. Dist. Perihelium.	Log. mean motion.	Eccentricity.	Direction.	Name of the Computer.
			h ′ ″	s ° ′ ″	s ° ′ ″	s ° ′ ″	° ′ ″						
52	51	1737	June 8 7 48 0	8 22 36 39	4 3 53 43	4 18 42 56	39 14 5	0.86700	9.93802	0.05313		D	Daussy
53	52	1739	17 11 7 0	3 12 34 0	6 27 18 0	3 14 44 0	55 53 0	0.67160	9.827111	0.219462		R	Zanotti
			20 9 24 0	3 5 11 0	6 25 18 0	3 20 7 0	53 25 0	0.69614	9.842697	0.196083		R	idem
			17 10 9 0	3 12 38 40	6 27 25 14	3 14 46 34	55 42 44	0.67358	9.828389	0.217546		R	La Caille
54	53	1742	Feb. 8 4 18 0	7 7 32 7	6 5 32 57	10 28 0 50	. . .	0.76550	9.883945	0.134211		R	Le Monnier
			8 4 30 30	7 7 33 44	6 5 34 45	10 28 1 1	67 4 11	0.765555	9.883976	0.134164		R	Struyck
			8 4 48 0	7 7 35 13	6 5 38 29	10 28 3 16	66 59 14	0.765680	9.884048	0.134058		R	La Caille
			8 7 40 0	7 7 39 10	6 5 42 41	10 28 3 31	66 52 4	0.765300	9.883832	0.134380		R	Zanotti
			7 10 49 0	7 10 49 23	6 9 32 7	10 28 42 44	61 43 44	0.752100	0.876224	0.145792		R	Euler
			7 22 0 0	7 7 33 28	6 5 47 22	10 28 13 54	68 14 0	0.768900	9.885870	0.131323		R	Wright
			8 5 28 0	7 7 26 23	6 5 29 28	10 28 3 5	67 11 9	0.766200	9.884342	0.133615		R	Klinkenberg
			8 7 22 0	7 7 37 50	6 5 41 32	10 28 3 42	66 51 0	0.765450	9.883917	0.134253		R	Houttuyn
			8 15 1 0	7 6 39 20	6 5 9 30	10 28 30 10	67 31 40	0.770055	9.886523	0.130344		R	Barker
55	54	1743	Jan. 10 21 24 57	3 2 58 4	2 8 10 48	0 24 47 16	2 15 50	0.838115	9.923303	0.075172		D	Struyck
			10 20 35 0	3 2 41 45	2 8 21 15	0 24 20 30	2 19 33	0.835010	9.921691	0.077593		D	La Caille
56	55	1743	Sep. 20 21 26 0	8 6 33 52	0 5 16 25	8 1 17 27	45 48 21	0.521570	9.717310	0.384159		D	Klinkenberg
57	56	1744	Mar. 1 8 26 20	6 17 12 55	1 15 45 20	5 1 27 35	47 8 36	0.222060	9.346472	0.940420		D	Betts
			1 8 24 0	6 17 5 49	1 15 46 52	5 1 18 57	47 3 35	0.223220	9.348733	0.937029		D	Maraldi
			1 8 13 0	6 17 10 0	1 15 46 11	5 1 23 49	47 5 18	0.222500	9.347325	0.939141		D	La Caille
			1 8 8 0	6 17 17 30	1 15 51 0	5 1 26 30	47 18 0	0.221560	9.345491	0.941892		D	Zanotti
			1 9 8 0	6 17 19 26	1 16 5 24	5 1 14 2	47 49 53	0.221920	9.346196	0.940834		D	Chéseaux
			1 8 2 0	6 17 11 58	1 15 46 6	5 1 25 52	47 10 53	0.222220	9.346783	0.939954		D	Euler
			1 8 3 3	6 17 13 4	1 15 47 53	5 1 25 11	47 8 29	0.222229	9.346801	0.939927		D	Pingré
			1 7 51 30	6 17 14 36	1 15 49 27	5 1 25 9	47 17 38	0.222000	9.346353	0.940599		D	Klinkenberg
			1 9 6 40	6 17 16 16	1 15 49 30	5 1 26 46	47 14 10	0.221756	9.345875	0.941316		D	Hiorter
			1 8 0 0	6 17 29 0	1 16 3 0	5 1 26 0	47 50 0	0.220400	9.343212	0.945310		D	Cassini
58	57	1747	Feb. 28 11 54 19	9 10 5 41	4 26 58 27	7 16 52 46	77 56 55	2.293880	0.360572	9.419272		R	Chéseaux
			Mar. 3 10 7 40	9 7 2 5	4 27 18 42	7 20 16 37	79 6 45	2.198590	0.342144	9.446912		R	Maraldi
			3 7 20 0	9 7 2 5	4 27 18 50	7 20 16 45	79 6 20	2.198510	0.342146	9.446936		R	La Caille
59	58	1748	Apr. 28 19 34 45	7 5 0 50	7 22 52 16	0 17 51 26	85 26 57	0.840665	9.924622	0.073194		R	Maraldi
			29 0 34 24	7 4 38 40	7 22 45 46	0 18 7 6	85 35 17	0.841500	9.925054	0.082547		R	Le Monnier
			28 18 53 30	7 5 23 49	7 22 51 50	0 17 28 1	85 28 23	0.840400	9.924486	0.073329		R	Klinkenberg

N.	Delambre	Date.	Passage of the Perihelium in Parisian mean time.	h ′ ″	Longitude of the Perihelium. s ° ′ ″	Longitude of the ascending node. s ° ′ ″	Angle between the Perihelium and the node. s ° ′ ″	Inclination. ° ′ ″	Distance in the Perihelium.	Log. Dist. Perihelium.	Log. mean motion.	Eccentricity.	Direction	Name of the Computer.
60	59	1748	June 18	1 33 0	9 6 9 24	1 4 39 43	8 1 29 41	56 59 3	0.655255	9.816407	0.235513		D	Struyck
			18	21 27 21	9 8 47 10	1 3 8 29	8 5 38 41	67 3 28	0.625357	9.796128	0.265936		D	Bessel
61	60	1757	Oct. 21	8 4 0	4 2 58 0	7 4 12 50	8 28 45 10	12 50 20	0.337542	9.528328	0.667636		D	Bradley
			21	9 42 0	4 2 39 0	7 4 5 50	8 28 33 10	12 39 6	0.339070	9.530288	0.664696		D	La Caille
			21	9 56 0	4 2 49 0	7 4 4 0	8 28 45 0	12 48 0	0.337970	9.528875	0.666816		D	Pingré
			21	9 23 0	4 2 36 29	7 4 7 11	8 28 29 18	12 41 7	0.339320	9.530610	0.664213		D	De Ratte
62	61	1758	June 11	3 27 0	8 27 38 0	7 20 50 0	1 6 48 0	68 19 0	0.215350	9.333148	0.960406		D	Pingré
(15)	16	1759	Mar. 12	13 33 0	10 3 14 0	1 23 48 0	3 20 34 0	17 38 0	0.583553	9.766080	0.311008		R	Messier
			12	13 59 24	10 3 8 10	1 23 45 35	3 20 37 25	17 40 14	0.584900	9.767085	0.309501		R	La Lande
			12	12 57 36	10 3 16 20	1 23 49 21	3 20 33 1	17 35 20	0.583600	9.766115	0.310956		R	Maraldi
			12	13 30 0	10 3 15 30	1 23 49 0	3 20 33 30	17 38 0	0.583810	9.766264	0.310732		R	La Caille
			12	13 41 0	10 3 16 0	1 23 49 0	3 20 33 0	17 39 0	0.583490	9.766039	0.311070		R	idem
			12	13 7 35	10 3 19 18	1 23 45 35	3 20 26 17	17 40 5	0.582973	9.765650	0.311653	0.9676567	R	Klinkenberg
			13	10 11 31	10 1 0 24	1 24 7 20	3 23 6 56	17 28 55	0.597075	9.776029	0.296085		R	idem
			12	13 22 0	10 5 23 0	1 23 44 55	3 20 21 55	17 41 20	0.582340	9.765176	0.312364		R	Bailli
			12	14 9 15	10 3 10 1	1 23 50 11	3 20 40 10	17 37 12	0.5845744	9.7668395	0.3098690	0.96754386	R	Burckhardt
63	62	1759	Nov. 27	0 11 57	1 23 34 19	4 19 39 41	9 3 54 38	79 6 38	0.801390	9.903844	0.104362		D	Pingré
			27	2 28 20	1 23 24 20	4 19 39 24	9 3 44 56	78 59 22	0.798510	9.902280	0.106708		D	La Caille
			27	0 43 19	1 23 38 4	4 19 40 15	9 3 57 49	79 3 19	0.802100	9.904218	0.103801		D	Chappe
64	63	1759	Dec. 16	21 13 0	4 18 24 35	2 19 50 45	10 1 26 10	4 51 32	0.965900	9.984972	9.982670		R	La Caille
			16	12 58 12	4 19 3 52	2 19 20 24	10 0 16 32	4 42 10	0.961800	9.983064	9.991532		R	Chappe
65	64	1762	May 29	0 27 48	3 15 22 23	11 18 55 31	3 26 26 52	85 22 21	1.014150	0.006102	9.950975		D	Maraldi
			28	15 27 0	3 15 15 0	11 19 20 0	3 25 55 0	84 45 0	1.012400	0.005380	9.952058		D	Lalande
			29	1 57 0	3 15 24 0	11 18 57 44	3 26 26 16	85 12 20	1.010650	0.004600	9.953228		D	Bailli
			28	2 1 53	3 13 42 38	11 18 35 24	3 25 7 14	85 40 10	1.006860	0.002969	9.955675		D	Klinkenberg
			28	7 0 49	3 14 29 46	11 19 2 22	3 25 27 24	85 8 2	1.009856	0.004259	9.953739		D	Struyck
			28	8 11 3	3 14 2 0	11 18 33 5	3 25 28 55	85 38 13	1.009048	0.003913	9.954259		D	Burckhardt
66	65	1763	Nov. 1	19 52 58	2 24 51 54	11 20 23 26	2 28 28 28	74 40 40	0.498767	9.697895	0.413286		D	Pingré
			1	20 50 19	2 25 0 48	11 26 29 29	2 28 31 19	72 39 29	0.498122	9.697597	0.413733		D	idem
			1	21 7 38	2 25 1 6	11 26 27 0	2 28 34 6	72 28 0	0.498190	9.697391	0.498185		D	Burckhardt
			1	20 49 47	2 24 58 58	11 26 24 4	2 28 34 54	72 31 52	0.498290	9.697478	0.413911	0.99868	D	idem
			1	21 4 19	2 24 57 27	11 26 17 38	2 28 39 49	72 34 10	0.495804	9.6953097	0.4171637	0.9954268	D	Lexell

N.	Delambre	Date.	Passage of the Perihelium in Parisian mean time.	Longitude of the Perihelium.	Longitude of the ascending node.	Angle between the Perihelium and the node.	Inclination.	Distance in the Perihelium.	Log. Dist. Perihelium.	Log. mean motion.	Eccentricity.	Direction.	Name of the Computer.
			h ′ ″	s ° ′ ″	s ° ′ ″	s ° ′ ″	° ′ ″						
67	66	1764	Feb. 12 13 51 36	0 15 14 52	4 0 4 33	3 14 49 41	52 53 31	0.555216	9.744462	0.343435		R	Pingré
			12 10 29 0	0 16 11 48	3 39 20 6	3 13 8 18	53 54 19	0.564176	9.751415	0.333006		R	idem
			12 13 39 57	0 15 26 3	4 0 7 33	3 14 41 30	52 46 39	0.556700	9.745621	0.341697		R	idem
68	67	1766	Feb. 17 8 50 0	4 23 15 25	8 4 10 50	3 10 55 25	40 50 20	0.505330	9.703570	0.404773		R	idem
69	68	1766	Apr. 22 20 55 40	8 2 17 53	2 14 22 50	5 17 55 3	11 8 4	0.332745	9.522112	0.676960		D	idem
			17 0 26 13	6 56 5 13	1 17 22 19	5 8 42 54	8 18 45	0.636825	9.804020	0.254098		D	idem
			16 17 30 0	6 25 15 0	1 17 5 0	5 8 10 0	8 20 0	0.6386	9.805230	0.252283		D	idem
			26 23 53 16	8 11 13 0	2 14 11 0	5 27 2 0	8 1 45	0.39898	9.6009506	0.5587024	0.864000	D	Burckhardt
70	69	1769	Oct. 7 12 30 0	4 24 5 54	5 25 0 43	10 29 5 11	40 37 33	0.123760	9.092580	1.331258		D	Lalande
			7 12 26 17	4 24 14 22	5 25 2 25	10 29 11 57	40 42 38	0.122980	9.089134	1.325977		D	Wallot
			7 13 13 8	4 24 11 8	5 25 3 18	10 29 7 50	40 46 32	0.122580	9.088420	1.327498		D	Cassini
			7 13 58 36	4 24 11 7	5 25 6 33	10 29 4 34	40 48 49	0.122720	9.088915	1.326756		D	Prosperin
			7 13 58 23	4 24 9 24	5 25 3 27	10 29 5 57	40 41 13	0.122890	9.089516	1.325854		D	Audiffrédi
			7 12 12 41	4 24 32 54	5 25 11 13	10 29 21 41	41 1 6	0.121000	9.082785	1.335951		D	Slop
			7 14 0 14	4 24 7 0	5 25 4 47	10 29 2 13	40 42 48	0.123070	9.090187	1.324848		D	Asclepi
			7 15 42 16	4 24 12 58	5 25 3 55	10 29 9 3	40 46 7	0.1227508	9.0890243	1.3265919	0.998709	D	idem
			7 11 17 0	4 25 46 0	5 24 42 0	11 1 4 0	41 28 0	0.116400	9.065953	1.361199		D	Lambert
			7 17 46 0	4 24 22 0	5 25 13 40	10 29 8 20	40 42 30	0.122800	9.089198	1.326331		D	Widder
			7 15 6 0	4 24 16 0	5 25 3 0	10 29 13 0	40 50 0	0.122640	9.088632	1.327180		D	Euler
			7 15 37 37	4 24 15 32	5 25 4 41	10 29 10 51	40 49 33	0.122690	9.088809	1.326915	0.9980036	D	Lexell
			7 15 51 23	4 24 15 53	5 25 6 4	10 29 9 49	40 46 42	0.122744	9.089002	1.321625	0.998932	D	Pingré
			7 12 17 13	4 24 38 57	5 25 9 33	10 29 29 24	40 59 50	0.120397	9.080617	1.329202		D	idem
			7 12 34 9	4 24 11 8	5 25 2 24	10 29 8 44	40 48 29	0.123285	9.090911	1.323662		D	idem
			7 15 2 42	4 24 11 29	5 25 3 59	10 29 7 30	40 45 50	0.122755	9.089039	1.326569	0.99924901	D	Bessel
			7 12 44 38	4 24 11 32	5 25 3 40	10 29 7 52	40 47 56	0.123270	9.090847	1.323857		D	Legendre
71	70	1770	Aug. 9 0 16 54	11 25 27 16	4 19 39 5	7 5 48 11	1 44 30	0.636878	9.804056	0.254044	0.7808695	D	Pingré
			9 0 19 17	11 26 7 16	4 16 39 5	7 9 28 11	1 44 29	0.629587	9.799056	0.271544		D	idem
			10 21 45 24	11 25 4 36	4 13 38 44	7 11 25 52	1 40 48	0.657995	9.818222	0.232795		D	idem
			9 0 3 46	11 26 6 40	4 15 28 43	7 10 37 57	1 46 31	0.629550	9.799030	0.261573		D	Prosperin
			8 9 9 16	11 22 51 22	4 15 3 42	7 7 47 40	1 44 35	0.614560	9.809263	0.246229		D	idem
			25 2 8 53	0 7 13 46	4 14 30 0	7 22 43 46	1 23 0	0.717170	9.855622	0.176695		D	idem
			12 20 50 0	11 29 45 0	4 12 56 0	7 16 49 0	1 46 0	0.649460	9.812552	0.241300		D	Widder

Art. XII.—MISCELLANEOUS INTELLIGENCE.

I. Mechanical Science.

1. *Cutting of Steel by Soft Iron.*—Mr. Barnes, of Cornwall, Connecticut, has ascertained a singular property of soft iron in cutting hard steel. He had fixed a circular plate of soft sheet iron on an axis, and putting it into a lathe, gave it very rapid rotatory motion, applying, at the same time, a file to it to make it perfectly round and smooth; the file, however, was cut in two by the plate, the latter remaining untouched; and it was found not to have been much warmed in the operation, though a band of intense fire surrounded it whilst in action.

A saw made of a very hard plate, which required altering, was cut through longitudinally in a few minutes, and afterwards teeth were cut in it by the same means. Had the file been used to produce the same effect, it would have required a long and tedious operation.

Rock crystal applied to the plate cut it readily.

Mr. Perkins, of Fleet-street, has verified this remarkable and useful observation. A piece of a large hard file was cut by him into deep notches at the end, where, also, from the heat produced by friction, it had softened and been thrown out like a burr. On another part of the file, where the plate had been applied against its flat face, the teeth were removed, without any sensible elevation of the temperature of the metal. The plate, which had previously been made true, was not reduced either in size or weight during the experiment, but it had, according to Mr. Perkins, acquired an exceeding hard surface at the cutting part.—*Silliman's Jour.* vi. 336.

2. *Water-proof Cloth.*—A chemist of Glasgow has discovered a simple and efficacious method of rendering woollen, silk, or cotton cloth completely water-proof. The mode adopted is to dissolve caoutchouc in coal tar oil, produced in abundance at the gas works; by a brush to put five or six coatings of this mixture on the side of the cloth or silk on which another piece is laid, and the whole passed between two rollers. The adhesion is most complete, so much so, that it is easier to tear the cloth than to separate it from the caoutchouc.

3. *Chain Bridge over the Tamar.*—A chain or suspension bridge across the Tamar, at Saltash, in Devonshire, is now seriously intended; and the wealthy landholders in Devon and Cornwall have readily come forward with offers of pecuniary assistance. It is to be of sufficient height to admit of frigates passing under without striking their jury masts. Such a bridge would be of great importance to that part of the country, for the numerous advantages it would confer.

4. *Pottery Painting*—An experiment, promising considerable success, has been made at Paris. It is an attempt to preserve the large paintings of the most distinguished artists, by the employment of plates of pottery. The different parts of a large picture are united by a composition, and so coloured as to disguise completely the joints. The artists who work at this experiment propose, by this means, to produce paintings as durable as mosaic, of much easier execution, and at a moderate price.

5. *Extinction of Fires in Chimnies.*—M. Cadet Vaux, reflecting on the circumstances of a fire, when it occurs in a chimney, was led to endeavour at its extinction, by rendering the air which passes up the flue unable to support combustion. This object he obtained by the simple means of throwing flour sulphur on the fire in the grate, and so effectual was it, that a fagot suspended in the chimney, very near the top, and consequently near the external air, when set on fire, and burning with great fury, was instantly extinguished on the application of the sulphur below. This process is the more applicable, inasmuch as it does not require that all the oxygen in the air should be converted into sulphurous acid gas, before it passes up the chimney; on the contrary, a comparatively small proportion of the latter gas, mixed with common air, is sufficient to prevent its supporting the combustion of common combustible bodies.

6. *Smut in Corn prevented.*—M. B. Prevost gives the following method of preparing seed corn, to prevent the smut: Into a cistern put one gallon of water, ale measure, and dissolve in it one ounce of sulphate of copper, for every bushel of corn to be prepared. Having two tubs that will contain about eight bushels; throw into one of them about two bushels of corn, and then pour on the solution till it covers the corn an inch or two; carefully remove any thing that floats on the surface. Put corn into the other tub, and treat it in the same manner. When the corn has reposed half an hour in the first tub, after being well stirred, put it to drain, in a strainer, over the second tub. When it no longer drips, place it in a heap, and it will soon be dry enough to sow. The effect of the solution is more certain, the dryer the corn is before it is immersed.

II. Chemical Science.

1. *Experiments with certain Substances under high Pressures, by* M. Cagnard de la Tour.—One of my tubes of glass, in which I had put water and a little sulphuret of carbon, presented, when heated, the following results: The water became at first milky, then resumed its transparence with a slight tint of green, which increasing with the temperature, at last became almost black. During the experiment the sulphuret of carbon became lighter than the water, and floated

on it some time before it became all vapour. As the tube cooled the green colour diminished by degrees, and the fluids took their first state except that the water was of a yellowish tinge, which, however, was much diminished by agitation.

The tube was again heated, with the intention of converting all the water into vapour, but soon after the deep green colour appeared, the tube broke.

Another tube, besides the same liquids, contained also a little chlorate of potash. The first effect of the heat was to dissolve the salt; on leaving it to cool, the water became milky, and the sulphuret of carbon, which previously floated, fell to the bottom with the crystallizing salt. Exposed to a higher heat, the liquor became of a sudden of a fine lemon yellow colour, accompanied with effervescence, and the formation of an oily looking globule which, when all was cold, remained liquid at the bottom of the tube, but no crystals were now deposited.

The tube being heated still more highly, the yellow liquid disappeared and was replaced by a small globule of liquid sulphur; this at a higher heat took on the colour and transparency of the ruby, but, when all was cold, had the ordinary appearance of sulphur. No trace of sulphuret of carbon appeared in the tube, except that when heated to a certain degree, the water became of a bluish colour. When cold the water was colourless and transparent. This coloration did not take place in another tube into which a larger proportion of chlorate of potash was put.

Sometimes small acicular crystals formed in these tubes, grouped five or six about a central point; sometimes nearly the whole mass was crystallized, this effect was only once obtained. On breaking the tube a very strong explosion took place, and the fluid was expelled from the tube; the water was strongly acid. It is remarkable that in these experiments the water did not at all effect the transparency of the glass, though, when alone, it produces that effect very rapidly.—*Ann. de Chim.* xxiii. 267.

2. *Fusion of Charcoal, Plumbago, Anthracite, and Diamond; probable productions of Diamonds, by* Professor Silliman.—Professor Silliman has lately been very active in ascertaining the effect of intense heat on charcoal, plumbago, and anthracite. The instruments he used were Dr. Hare's galvanic deflagrator and his compound oxy-hydrogen blow-pipe. Fusion was generally produced, and, in some cases, results which apparently approximate so nearly to diamond as to give great interest to the experiments. The following passages are partly extracted, partly condensed from some of his papers on the phenomena. The papers at length may be referred to in *Silliman's Journal*, vol. vi.

With regard to the fusion of plumbago, the best results were obtained when the plumbago was connected with the copper pole, and prepared

charcoal with the zinc pole*. The spark was vivid, and the globules of melted plumbago could be discerned, even in the midst of the ignition, forming and formed upon the edges of the focus of heat. There were also bright scintillations from combustion, and just on, beyond the confines of the ignited portion of plumbago, was formed a belt of a reddish brown colour, supposed to be iron, from the combustion of the plumbago in that place. The globules were frequently so abundant as to look like a string of beads, the largest of the size of the smallest shot, others quite microscopic. No globule appeared on the point of the plumbago which had been in the focus of heat, but here a hemispherical excavation existed, and the plumbago looked like black scoria.

On the zinc pole, with prepared charcoal, there were peculiar results; the pole was always elongated towards the copper pole, and the black matter accumulated there presented every appearance of fusion, not into globules but into a fibrous and striated form, like half-flowing slag. "It was evidently transferred in the state of vapour from the plumbago of the other pole, and had been formed by the carbon taken from the hemispherical cavity," and was very different to the melted charcoal obtained when both poles were terminated by that substance. On the end of the prepared charcoal were found numerous globules of perfectly-melted matter, spherical, and of a high vitreous lustre. Those most remote from the focus were sometimes of a jet black like obsidian, others brown, yellow, and topaz coloured, others greyish white like pearl-stones, with the translucence and lustre of porcelain, and others again were limpid like flint-glass, or like hyalate, or precious opal, but without colour. Few of the globules on the zinc pole were perfectly black, few on the copper pole were otherwise, except in one instance, when very pure plumbago from Borrodae was used, and they were then white and transparent. When the points were held vertically, and the plumbago uppermost, no globules were found on the latter, and they were unusually numerous and almost black on the opposite pole. When the points were changed, plumbago being on the zinc, and charcoal on the copper end, very few globules were formed on the plumbago, and none on the charcoal, the last being rapidly hollowed; whilst the plumbago was as rapidly elongated by matter accumulating at its point, which, by the microscope, appeared to be a concretion in the shape of a cauliflower of volatilized and melted charcoal.

Some of the globules being bedded in a handle of wood, bore strong pressure without breaking, and easily scratched flint, window and hard green glass. They sunk rapidly in strong sulphuric acid, much more so than the *melted* charcoal, but not much more so than the plumbago, from which they were formed.

With a new deflagrator good results were obtained, using plumbago at both poles. The pieces of plumbago were one-fifth of an inch

* The apparatus is in the condition of a single pair of plates.

diameter, and one or two inches long. The globules, now extended from one quarter of an inch of the end to the distance of one-fourth or one-third of an inch all round. They were perfectly visible to the naked eye, and of all the colours before-mentioned; some were so limpid as not to be distinguishable from diamond. In one instance only was a globule found on the point; "it would seem as if the melted spheres of plumbago, as soon as formed, rolled out of the current of flame, and congealed on the contiguous parts. The excavation on the copper side, and accumulation on the zinc side, were constant. The result too obtained when the charcoal was on the copper, and the plumbago on the zinc side was constant. The charcoal was rapidly volatilized, a cavity formed, and the matter removed accumulated upon the plumbago point, forming a protuberance easily distinguished from the plumbago; and when seen by the microscope presenting an aggregation of spheres with every mark of perfect fusion, and with a perfect metallic lustre."

In another experiment the spheres were very numerous and white like calcedony, "they appeared to me to be formed by the condensation of a white vapour, which in all the experiments where an active power was employed, I had observed to be exhaled between the poles, and partly to pass from the copper to the zinc pole, and partly to rise vertically in an abundant fume, like that of the oxide proceeding from the combustion of various metals;" this fume is easily condensed on glass held over it, rendering it opaque from a white lining; there was a distinct and peculiar odour in the fume, but the condensed matter was tasteless, did not effervesce with acids or effect test papers; it was concluded, therefore, not to be alkali: "it seems possible that it is white volatilized carbon, giving origin by its condensation in a state of greater or less purity to the grey, white, and, perhaps, to the limpid globules."

Some of the coloured globules were collected together, they rolled about like shot; they were rubbed in the hand to free them from plumbago, and then placed upon a fragment of Wedgwood-ware floated in a dish of mercury, and a small jar of very pure oxygen gas, previously washed and tested by soda and lime-water slid over them. The globules were heated by a powerful lens; for half an hour they did not melt, disappear, or alter their form, but carbonic acid was afterwards found in the gas on examination with lime-water. "In a long-continued experiment, it is presumable that they would be eventually dissipated, leaving only a residuum of iron. That they contain iron is manifest from their being attracted by the magnet, and the colour is evidently owing to the metal." "It would be interesting to know whether the limpid globules are also magnetic; but this trial I have not yet made."

In some cases the white fume collected in considerable quantities on the charcoal, and looked like a frit of white enamel, or a little like pumice-stone. "Had we not been encouraged by the remark-

able facts already stated, it would appear very extravagant to ask whether this white frit, and these limpid spheres, could arise from carbon volatilized in a white state, even from charcoal itself, and condensed in a form analogous to the diamond. The rigorous and obvious experiments necessary to determine this question, it is not now practicable for me to make, and I must, in the mean time, admit the *possibility* that alkaline and earthy impurities may have contributed to the result."

With respect to the passage of matter from one pole to the other, the eyes being protected by green glasses, "I can distinctly observe matter in different forms passing to the zinc pole and collecting there just as we see *dust, or other small bodies,* driven along by a common wind: there is also an obvious tremor produced in the copper pole when the instrument is in vigorous action, and we can perceive an evident vibration produced as if by the impulse of an elastic fluid striking against the opposite pole."

Such were the experiments with the deflagrator; the following relate to the same subject, and were made with the compound blow-pipe. The diamond was supported on a piece of limestone, and when subjected to the heat rapidly consumed, but when removed from the flame exhibiting marks of incipient fusion. The surface became dull and irregular, as if softened and indented by the stream of gas, or as if irregularly removed by combustion.

Anthracite under similar treatment consumed rapidly, but still had an evident appearance of being superficially softened, and there could be distinctly seen, "in the midst of the intense glare of light, very minute globules forming upon the surface. These when examined by a magnifier proved to be perfectly white and limpid, and the whole surface of the anthracite exhibited like the diamond, only with more distinctness, cavities and projections united by flowing lines, and covered with a black varnish" like a slag.

Plumbago presented numerous globules to the naked eye, seen through a glass they were perfectly white and transparent spheres. In some experiments they were as large as small shot; scratched window-glass, were tasteless, harsh when *crushed* between the teeth, and not magnetic. They resembled melted silex, and might be supposed to originate from impurities "had not their appearance been uniform in the different varieties of that substance," which has never yet presented any combined silex, and no foreign substance could be detected either by the glass or the fingers; "add to this in different experiments I obtained very numerous perfectly black globules on the same pieces which afforded the white ones. In one instance they covered an inch in length all around, many of them were as large as common shot, and they had all the lustre and brilliancy of the most perfect black enamel." Here and there were globules of the lighter coloured varieties.

After some further arguments and statements, in which the non-

conducting power of these bodies for electricity is insisted on, and which we regret we have not room to state. Professor Silliman says, "It will now, probably, not be deemed extravagant if we conclude that our melted carbonaceous substances approximate very nearly to the condition of diamond." Admitting this, yet the interest and importance which would attach to the discovery of the artificial production of diamond, justifies us in reserving our doubts whilst reading Professor Silliman's statements. The experiments are very important, but many doubts arise, even whilst reading the description only. That the vapour, which is described as rising from the charcoal and plumbago, and which formed a kind of frit, and was supposed to be the matter of the globules, could be carbon in any state, is almost impossible; it neither accords in its properties with charcoal or diamond. Sir G. Mackenzie shewed that a mere red heat was sufficient to burn solid diamond even in the common atmosphere, so that it is hardly probable a vapour at all like diamond could escape through the air so intensely heated, and condense on a glass-plate unburnt. The properties of the globules, also, continually fall short of those of the diamond. We would beg to suggest what we think would be a ready test of their nature, namely, trial by the blow-pipe. The diamond, heated with borax on the platinum wire, before the blow-pipe, undergoes no change; we are afraid the globules would not stand the trial, but hope the Professor will be induced by its readiness to submit them to it.

3. *Action of Nitric Acid on Charcoal, production of Cyanogen.*— The following account is abstracted from a paper by Dr. Cutbush, in *Silliman's Journal*, vol. vi. 149. Nitric acid was poured on to charcoal to illustrate the nature of gunpowder by a reference to the composition and decomposition of the acid; and being left, the mixture became, after the usual action, thick and brown, like artificial tannin. It was thought that perhaps cyanogen might be formed by the union of part of the carbon with nitrogen, at the same time with the carbonic acid and nitrous gases. The mixture was therefore put into a retort, distilled, and all the products passed through a series of Woulfe's bottles, containing water. Most of the gases were thus absorbed, and the acid solution neutralized by potash. The solution was then tested by sulphate and persulphate of iron, when the colour immediately changed, and became more or less blue, thus proving the presence of cyanogen in the results of the action of charcoal and nitric acid; so that at the same time that one portion of charcoal has taken the oxygen of the nitric acid, another portion must have taken its nitrogen.

The author of the paper observes, that charcoal has the property of absorbing many gases, and particularly hydrogen. He asks whether the charcoal he used might not contain hydrogen; and whether this nascent hydrogen, during the action of the carbon, might not have

acted on a portion of the acid, taking its oxygen and leaving its nitrogen in the state in which it might combine with the carbon and produce the cyanogen.

4. *Crystallized Carbon—Artificial Plumbago.*—At page 159, of our last volume, is an account of artificial plumbago formed in gas retorts, from a paper by the Rev. J. J. Conybeare, in the *Annals of Philosophy*. Mr. Herapath, in a late paper in the *Philosophical Mag.* lxi. 423, has shewn that this substance is not what it was at first supposed to be, inasmuch as it is pure carbon. Mr. Conybeare had operated on a portion taken from near the side of the retort, and hence the iron he found in it. As observed by Mr. Herapath, at the Bristol gas works, it is hard and very solid with a mammellated surface, from which scales may sometimes be detached. Its specific gravity is 1.865. When broken its crystalline form is very visible, and may be compared to starch. Mr. Herapath thinks its primitive form is the tetrahedron. In fine powder it loses its grey lustre and becomes a deep black.

When burnt with peroxide of copper, it requires so much heat that the black glass tubes generally give way. Even with chlorate of potassa it is necessary to repeat the process several times, but little being consumed each time. Nitre has still less effect on it. It is a good conductor of electricity.

Mr. Herapath remarks, that as it is found in thin layers, it is evident that its source is the gas, and its deposition on the hottest part of the retort, shews that coal gas should not be exposed to a greater heat than that at which it is produced. It is observed, too, that if this substance should turn out to be of the same composition as the diamond, and the only difference be that the diamond has twice the number of atoms in the same space, which is probable, from its specific gravity being 3.5, it might throw some light upon the cause of opacity and transparency.

[We would just remark here, that the necessary presence of iron in plumbago is a point not conceded by all chemists.—Ed.]

5. *Action of Steam on Solutions of Silver and Gold.*—The following observations on the action of steam on solutions of silver and gold, were made by Professor Pfaff, whilst investigating the volatility of muriates contained in boiling water. When the vapour of pure distilled water is made to pass through a solution of nitrate of silver, the solution assumes all the shades between yellow and dark brown, according to its concentration, and the time the steam has passed through it. When the solution has acquired 212° the colour increases rapidly. If several glasses are connected, and successively raised to the boiling point, by the steam passing through them, all become coloured. Nitric acid destroys the colour of this solution of nitrate of silver, and whilst the steam is acting oxygen is disengaged. When steam is passed through a solution of gold, a blue liquid is produced, like that

obtained by adding oxalic acid to a solution of gold. Thus, it seems proved, that the steam acts in producing these effects by deoxidizing the salts of silver and gold. Muriate of platina, or either of the nitrates of mercury, were unaffected by similar treatment.

6. *Change of Musket Balls in Shrapnell Shells.*—Mr. Marsh of Woolwich gave me some musket balls, which had been taken out of Shrapnell shells. The shells had lain in the bottom of ships, and probably had sea water amongst them. When the bullets are put in, the aperture is merely closed by a common cork. These bullets were variously acted upon: some were affected only superficially, others more deeply, and some were entirely changed. The substance produced is hard and brittle, it splits on the ball, and presents an appearance like some hard varieties of earthy hæmatite; its colour is brown, becoming, when heated, red: it fuses, on platinum foil, into a yellow flaky substance like litharge. Powdered and boiled in water, no muriatic acid or lead was found in solution. It dissolved in nitric acid without leaving any residuum, and the solution gave very faint indications only of muriatic acid. It is a protoxide of lead, perhaps formed, in some way, by the galvanic action of the iron shell and the leaden ball, assisted, probably, by the sea water. It would be very interesting to know the state of the shells in which a change like this has taken place to any extent; it might have been expected, that as long as any iron remained, the lead would have been preserved in the metallic state.—M. F.

7. *Action of Gunpowder on Lead.*—Mr. Marsh gave me also some balls from cartridges about fifteen years old, and which had probably been in a damp magazine. They were covered with white warty excrescences rising much above the surface of the bullet, and which, when removed, were found to have stood in small pits formed beneath them. These excrescences consist of carbonate of lead, and readily dissolve with effervescence in weak nitric acid, leaving the bullet in the coroded state which their formation has produced. It is evident there must have been a mutual action amongst the elements of the gunpowder itself, at the same time that it acted on the lead; and it would have been interesting, had the opportunity occurred, to have examined what changes the powder had suffered.—M. F.

8. *Inflammation of Gunpowder by Slaking Lime.*—In consequence of the application of quick-lime to the dessication of various substances, the *Comité consultatif de la Direction des Poudres et Salpêtres*, made some trials of the temperature produced by slaking lime. They found that it frequently rose so high as to inflame gunpowder thrown upon it; and that, even when enclosed in a glass tube, and the tube put in among the lime, the heat was sufficient to fire the gun-

powder. Hence quick-lime would be a dangerous desiccator in a powder-house.—*Annales de Chim.* xxiii. 217.

9. *Purple Tint of Plate Glass affected by Light.*—It is well known that certain pieces of plate glass acquire, by degrees, a purple tinge, and ultimately become of a comparatively deep colour. The change is known to be gradual, but yet so rapid as easily to be observed in the course of two or three years. Much of the plate glass which was put a few years back into some of the houses in Bridge Street, Blackfriars, though at first colourless, has now acquired a violet or purple colour. Wishing to ascertain whether the sun's rays had any influence in producing this change, the following experiment was made: three pieces of glass were selected, which were judged capable of exhibiting this change; one of them was of a slight violet tint, the other two purple or pinkish, but the tint scarcely perceptible, except by looking at the edges. They were each broken into two pieces, three of the pieces were then wrapped up in paper and set aside in a dark place, and the corresponding pieces were exposed to air and sunshine. This was done in January last, and the middle of this month, (September,) they were examined. The pieces that were put away from light seemed to have undergone no change; those that were exposed to the sunbeams had increased in colour considerably; the two paler ones the most, and that to such a degree, that it would hardly have been supposed they had once formed part of the same pieces of glass as those which had been set aside. Thus it appears that the sun's rays can exert chemical powers even on such a compact body and permanent compound as glass.—M. F.

10. *On the Uncertainty of Chemical Analysis, by* M. Longchamp.—The following is the conclusion of a very interesting memoir on the uncertainty of some results of chemical analysis; we shall endeavour to return to the memoir at some opportunity.

" It results from the experiments stated in this work, that the analysis of salts presents an uncertainty of which it is difficult to appreciate, at present, the whole extent; and that the cause, until now unperceived, is, that the sulphates of barytes and lead, and chloride of silver, carry with them, whilst precipitating, some part of the elements in the midst of which they are formed; and if to this be added the uncertainty presented by the carbonate of lime obtained from the decomposition of calcareous salts, resulting, probably, from the same cause, one will be ready to admit as a general law, that whenever an insoluble salt forms in the midst of a liquid it carries with it a portion of the surrounding substances. This observation, chemically important, probably will be so also to the mineralogist and geologist, inasmuch as it may tell in what circumstance a mineral mass has been formed: for it is probable that the substances which have been found in small quantity only in minerals, have been enveloped at the time of

their precipitation, and, consequently, these substances have existed dissolved, in greater or smaller quantities, in the liquid from which the minerals originated.

"It results from my experiments, that the nitrate of barytes ought to be proscribed our laboratories, as it gives results far more uncertain than the muriate. It is the same with the nitrate of lead, which is still more uncertain. M. Berzelius has frequently used it, particularly in the analysis of vegetable acids, gum, starch, *&c.*; and I believe, that notwithstanding the pains he has taken not to use nitrate of lead in excess, he has not been able to obtain results without serious errors, and that thus it is that the analyses of M. Berzelius differ frequently from those made by other chemists.

"The alkaline subcarbonates cannot be employed to estimate with precision the quantity of lime dissolved by an acid in solution; and the salts of lime cannot, in any circumstance, serve to estimate the quantity of any alkaline subcarbonate in solution.

"Finally, it results, that if by rigorous methods we succeed in determining the proportions of the elements of salts, chemical analysis, in general, would still not be more free from uncertainty; for if, for example, one perfect analysis of sulphate of barytes was made, it would not be less true that a solution of muriate of barytes being poured into any solution, to separate the sulphuric acid, the sulphate of barytes, which, by its weight, is to indicate the quantity of the acid, having carried with it a certain portion of the elements, in contact with which it was formed, would always give results, more or less removed from the truth, since its weight would be complicated with that of the impurity."—*Ann. de Chim.* xxiii. 241.

11. *Solubility diminished by heat.*—If phosphate of iron be dissolved in sulphuric acid, and the solution be diluted with some hundred times its volume of water, a portion of the phosphate will be precipitated, but some will remain in solution. On submitting this solution to ebullition, some white flocculi of phosphate of iron will appear; on cooling, the phosphate will be re-dissolved; and these changes may be repeated at pleasure. "It appears to me," says M. Longchamp, "that this result can only be explained by supposing that the sulphuric acid quits the phosphate it previously holds in solution, to go to the water, and oppose its resolution into vapour; and that when by fall of temperature the caloric exerts no further molecular disintegrating action, the acid goes again to the phosphate it had abandoned, and dissolves it."

"It is also by the action which liquid water exerts on that which is vaporizing, that we may explain why lime and magnesia are more soluble in cold than in hot water."—*Ann. de Chim.* xxiii. 192.

12. *Inflammability of Ammoniacal Gas.*—Professor Silliman observes, that if a large jar of ammoniacal gas be opened in the air,

beneath a burning candle, it is so combustible, that as it mixes with the air it will burn with a voluminous flame, forming a striking experiment. In small jars it will not burn, because it cannot mix sufficiently with the air, or is dissipated, or preserved cool by the vessel.—*Silliman's Jour.* vi.

13. *Amalgamation of Nickel and Cobalt by Arsenic.*—It is known that arsenic will amalgamate with mercury, but the influence which it exerts in causing the amalgamation of other metals, which when pure, shew no tendency to combine with mercury, is not known. Wishing to amalgamate a portion of argentiferous grey cobalt, mixed with kupfernickel, seventeen ounces were pulverized and mixed with mercury, added by degrees, in a mortar. After adding eighteen ounces of mercury, an amalgam was obtained, which, when washed and dried, weighed twenty-two ounces. The amalgam had adhered to the mortar and pestle in considerable quantities.

The mercury was separated from the amalgam by heat, and left ten and a half ounces of a metallic substance, of a fine silvery white; when roasted it gave out a strong odour of garlic, and consisted principally of cobalt and nickel.

A grey cobalt mixed with kupfernickel from Allemont, and not containing above 0.02 of silver, presented the same phenomena.—*Jour. de Phy.*, lxxxiv. 167.

14. *Chromium in Ore of Platinum.*—It has been shewn by a correspondent in the *Annals of Philosophy*, vi. 198, that the ore of platina contains chrome. It may easily be detected by separating the black sand, by means of a magnet, and fusing it with carbonate of potash in a strong heat, when chromate of potash is found in the crucible. Its nature was proved by dissolving the fused mass, neutralizing and precipitating with acetate of lead, a yellow precipitate fell down. This collected and treated with muriatic acid, gave a white salt, and an orange liquid which, after some boiling, became green.

Vauquelin first remarked the existence of chrome in the ore of platinum, but Tennant threw a doubt on the subject, by stating his inability to find it there.

15. *Test of Platinum.*—Professor Silliman recommends the hydriodic acid, as the best test for platinum in solution. When dropped into a weak solution, it almost immediately produces a deep wine red, or reddish-brown colour, which by standing grows very intense. It resembles the effect of muriate of tin, but is more sensible. On remaining a day or two, films of platinum were deposited. The hydriodic acid had been prepared, by putting phosphorus to about an equal bulk of iodine, placed under water in a glass tube, so that it remained mixed with acids of phosphorus, and perhaps phosphorus itself. No other metallic solution gave similar results.—*Silliman's Jour.* vi. 376.

16. *Combustion by Blow-pipe under Water.*—Mr. Skidmore, of New York, has remarked that the flame of the oxy-hydrogen blow-pipe may be made to burn under water. All that is required is to introduce it slowly, so that the flame shall not recede into the vessel. In this situation the flame is globular; wood put into it burns, and wires are ignited, and Mr. Skidmore thinks it may be very importantly applied as a submarine instrument of naval warfare, no difficulties being presented which may not easily be overcome.

17. *Composition of James's Powders.*—Mr. Phillips finds James's powders, purchased from Messrs. Newbery's, St. Paul's Church-yard, to consist of

Peroxide of antimony	56.0
Phosphate of lime	42.2
Oxide of antimony, impurity, and loss . .	1.8
	100.

The quantity of protoxide of antimony contained in the powder was so small, "that it would have been nearly impossible to have ascertained its weight."—*Ann. Phil. N. S.* vi. 189.

18. *Adulteration of Ultramarine.*—The following remarks on the detection of impurities in ultramarine are by Mr. Phillips, and are briefly extracted from a paper, by that chemist, on the colouring matter of lapis lazuli.

Genuine ultramarine loses its colour when put into an acid leaving insoluble matter of a dirty white colour, and affording a colourless solution. It is not injured by boiling in solution of potash. It is not injured by being heated.

If it be adulterated with blue verditer, upon being heated it will become immediately greenish, and eventually black; when put into an acid, a greenish or bluish solution is obtained, which, on the addition of ammonia, becomes of a deep blue colour. The bluish acid solution will deposit copper upon iron, and, if much verditer be present, an effervescence will be produced by the action of the acid on it. If Prussian blue be present, heat will cause it to darken very much; when boiled with a little alkali in solution, the colour will become browner, and if there be not too much alkali, the solution obtained will precipitate a solution of iron of a deep blue colour. If indigo be present, heat will volatilize it in the form of a blue vapour, and sulphuric acid will not destroy the colour of the indigo. Smalts may be detected by their resisting the action of acids. Thenard's blue may be distinguished in a similar way.

Mr. Phillips has failed, like many other chemists, in ascertaining the colouring matter of lapis lazuli, but he has almost shewn that it cannot be a metal or metallic compound. He rather inclines to the opinion that it is due to a peculiar non-metallic substance, of what nature is uncertain.—*Ann. Phil. N. S.* vi. 34.

19. *On the presence of Iodine in the Waters of Sales, Piedmont.*—The waters of Sales spring in considerable quantities from an argilo-calcareous ground at the foot of a hillock, on the left-hand side of the torrent Staffora, near the road to Godiaso, not far from Sales, in the province of Voghera. They are turbid and of a faint yellow colour. They have a strong odour approaching to that of urine, or a muriatic residuum; their taste is brackish and sharp; bubbles of air constantly rise from the bottom of the reservoir containing them. Their temperature is that of the atmosphere; their specific gravity 1.0502. In 1788 the Canon Volta analyzed them, and found a twelfth of muriate of soda. In 1820, M. Romano repeated the analysis, and found muriate of soda, several earthy muriates, and a little oxide of iron. M. Laur. Angelina, of Voghera, on using starch as a re-agent, found a blue colour produced in the water, indicating the presence of iodine, and using the process generally adopted with the mother waters in the manufacture of soda, he succeeded in procuring a certain quantity of iodine from the water.

It is remarkable that, for a long time, the water of Sales has been administered successfully in scrofulous cases, and in cases of the goitre.—*Jour. des Mines*, viii. 293.

20. *Evolution of Gas during Metallic precipitation.*—M. Rivero has remarked, that inflammable gas is developed when zinc is made to act on chloride of silver to reduce it. M. Despretz has since remarked, that in the precipitation of one metal by another, gas is always liberated when the two metals form an energetic voltaic combination; thus it will happen with any two of the three metals, silver, copper, and zinc. Its source, therefore, is voltaic electricity.

21. *Electro-Magnetic effects of Alkalies, Acids, and Salts, by* M. Yelin.—The magnetic needle used by M. Yelin, was nearly 1.6 inches long, and .008 of an inch in diameter. It weighed little more than half a grain, and was delicately suspended by a spider's web, from a rod passing through the top of a glass cylinder, so that it could be raised or lowered at pleasure. The bottom of the instrument is a piece of card-board, on which circles are marked and divided, indicating the number of degrees through which the needle may have moved.

The conductor, whose state was to be indicated by this needle, was sometimes a band of tin 0.4 of an inch broad, and 24 inches long; sometimes a brass wire helix, which being brought up close beneath the needle, formed a kind of condenser, and rendered the action more sensible.

1. The tin band was placed under the needle, both being parallel to the magnetic meridian, a small glass was filled with muriatic acid; the end of the band, towards the austral pole of the needle, was plunged into the acid, and in a few moments after, the other extremity was immersed, immediately the austral pole went to the east. The experiment being repeated, except that the end of the band,

corresponding to the boreal pole of the needle, was first immersed, the austral pole went to the west. When in place of muriatic acid, a solution of ammonia, mineral alkali (soda), or sal-ammonia, was used, the results were exactly the same; but if a solution of vegetable alkali (potash) was used, the deviations were all in the opposite directions. Pure water produced no effect but $\frac{1}{500}$ of acid made it active. All solutions of salts, or acid, thus applied, produced an effect on the needle. It appears in these cases that, according as the first contact is made to the right or left, an arrangement of molecules is established in the fluid, proper to form a species of pile of which the two poles are very distinct, and that the whole of this little pile is reconstructed in the opposite direction, when the contact is made in the opposite way.

Place the needle over the condenser, the wires of the latter and the needle being parallel to the magnetic meridian, hold a cylinder of zinc in perfect contact with each end of the wire of the condenser, the arrangement will then be zinc, brass, zinc; plunge the cylinder corresponding with the austral pole of the needle into muriatic acid, and then plunge the other into the same acid, the austral pole of the needle will go towards the east. Repeat the experiment with nitric acid and fresh cylinders of zinc; now the austral pole of the needle will go towards the west. These and other results are the same, whether the conductors are put in contact with the metals before or after their immersion in the fluid.

The needle condenser and metal bars (zinc), being as before, let the glass be filled with a solution of potash, then immerse the end of the bar corresponding to the austral pole of the needle, and afterwards the other bar, the austral pole will deviate to the east. Take the bars out of the solution, but without changing their position in the hands, and as soon as the needle is at rest, introduce them again, beginning with the bar corresponding to the boreal pole of the needle; the needle (the austral pole) will now deviate to the west. Take the bars out of the fluid, and, without changing them from hand to hand, turn them, so that the ends which were before immersed in the liquid, shall now be in contact with the extremities of the condenser wire, then repeat the above experiments, and the *same* results will be obtained. Finally, if the bars, being well cleaned, are changed from hand to hand, and the experiments again repeated, the same results will be produced.

But now, preserving the apparatus as it was, change the solution of potash for very pure muriatic acid. The zinc bar, corresponding to the boreal pole, being first immersed in the acid, the austral pole will go eastward. Remove that bar from the acid which was last plunged in, and a little while after, the other bar, and without changing them at all in the hand, wait till the needle is quiet; commence by the bar corresponding to the boreal pole; at the moment when that which agrees with the austral pole shall touch the acid the needle (the austral pole) will deviate towards the *west*, and

it will go in the same direction as often as the experiment is repeated, whether the operation be began on the *right or on the left hand.*

If the bars be then well washed and dried, and restored to the ends of the condenser wire they were in contact with before, but with that part which was before immersed, now in contact with the wire, and the immersions and experiment be repeated, one of two things will happen, either the needle will constantly move to the east, whichever bar is first immersed, or the action will be very doubtful or null.

If, instead of turning the bars, they are changed one for the other, the needle will go constantly to the *west,* whichever bar is first immersed; but the previous results may be at any time restored by re-changing the bars, and then the needle will go to the east.

The faculty thus acquired by the bars of zinc, of becoming positive or negative, according as they are plunged either first or last in the acid, they preserve some time. They may be washed, dried, and held in the hand, without losing their state, and hence particular precautions are required in making delicate experiments with the metals.

This faculty is not communicated either to the fluid or to the extremities of the condenser wire. All the metals which become magnetomoters by muriatic acid, as well as all the acids which produce an electro-magnetic action with homogenous metals, produce the same phenomena.

These experiments may be compared, with interest, with the observations of M. Volta, that a band of wet paper, making part of the conductor of his pile, becomes charged with electricities, which it preserves some time; with that of M. Gautherot, who thought he remarked something similar in the conducting wires of the pile, and with that of M. Ritter on his secondary piles, the phenomena of which M. Volta attributed to the electromotive action of the alkalies and salts interposed. "A very decided electric charge may be remarked in the metals interposed between the conductor and the fluid; they are both unipolar, *i. e.*, charged each with a single electricity, which they retain for some time, and this electricity is constantly positive in one, and negative in the other. They form, therefore, the elements of a species of pile, of which the extremities may be detached without losing their electricity; and, in consequence of this property, I call it a *secondary pile with mobile unipolar extremities.*"

"I have sometimes succeeded, with bars of some length, in obtaining distinct poles at each extremity, so that when the bars were turned, opposite results were presented by the needle; but I have not been able to discover the condition of this phenomenon, so as to be able to produce it at pleasure."

M. Yelin remarks, however, that he has never yet been able to ascertain the existence of free magnetism or electricity in any of these bars. Many other experiments are given in tables, which we have not room to notice, though they are of great interest. The bars M. Yelin used were .275 of an inch in diameter, and 2.75 inches long.—*Bib. Univ.* xxiii. 38.

22. *Table of Thermoelectrics by* Professor Cumming.—The following table of thermoelectrics is by Professor Cumming: they being used two together, each substance is positive to all below, and negative to all above. The voltaic series, and the order of conductors of electricity and heat, are added merely to shew that the thermo-electric series has no accordance with either of them.

		Conductors of	
Thermo-electric.	Voltaic Series.	Electricity.	Heat.
Bismuth	Charcoal	Silver	Silver
Mercury	Platina	Copper	Gold
Nickel	Gold	Lead	Tin
Platina	Silver	Gold	Copper
Palladium	Copper	Zinc	Platina
Cobalt	Lead	Tin	Iron
Silver	Tin	Platina	Lead.
Tin	Iron	Palladium	
Lead	Zinc	Iron	
Rhodium			
Brass			
Copper			
Gold			
Zinc			
Charcoal			
Plumbago			
Iron			
Arsenic			
Antimony			

Ann. Phil. N.S. vi. 170.

23. *Horizontal Plate Electrical Machine.*—Dr. Hare, of Pennsylvania, has suggested and practised a new mode of mounting the plate of an electrical machine, by which it is made to afford negative electricity as readily as positive, without losing any of the advantages which the plate-machine has over the cylinder. The plate is made to revolve horizontally, and is supported on an upright iron bar, about an inch in diameter, which rises through a table on which the machine stands. The bar rests beneath the table on a brass step, and is furnished with a wheel and band, by which motion is given to the machine. Its upper end is fastened by a block of wood and cement, into a glass cylinder 4½ inches in diameter and 16 inches long, which, being open only at the lower end, forms a perfect insulation. A brass cap surmounted by a screw and shoulder is cemented on to the cylinder, and the plate is fastened on by means of the screw, a nut, and discs of cork. Thus the plate, which is 34 inches diameter, is mounted; and two cushions, of which there are two pair, placed opposite to each other, as in the common machine, and the conductors are mounted in a similar way, except that wood is used in place of iron. The two rubbers connect together by an arched brass rod, and the

two conductors by another arch of the same kind; these, therefore, act as the positive and negative conductors. There is no undue strain upon any part of this machine, and it is found on practice to excite well and insulate perfectly.—*Phil. Mag.* lxii. 8.

24. *Carbonic and Muriatic Acids of the Atmosphere.*—According to M. Vogel, scarcely any carbonic acid can be found in the atmosphere over the sea two or three miles from shore, even barytes water almost fails to detect it. On the other hand, various Dutch chemists have pointed out the existence of muriates, and even free muriatic acid in the atmosphere. The latter seems most decided near the sea-shore, and is most abundant in dry weather. At Amsterdam it appeared to be particularly abundant; but is attributed in part, at least, to the action of sulphuric acid formed by the combustion of coal and peat, which acting on the muriates set their acid free.

25. *Vegetable Alkali from Rhubarb.*—M. Nani, of Milan, states, that he has discovered a new vegetable alkali in rhubarb; but has not, as yet, said much of its properties, and except its solubility in weak sulphuric acid, and precipitation by lime, no evidence of its alkaline nature is offered. Six ounces of rhubarb in powder were boiled for two hours in eight pints of common water with four drams of sulphuric acid, it was filtered, pressed, and the residuum re-boiled with six ounces of water and two drams of sulphuric acid, the fluid being again separated, the residuum weighed but two ounces. The united infusions were mixed by degrees with three ounces of quick-lime, and from being yellow became of a blood-red colour; after standing a day the precipitate was filtered out, dried in the sun, and weighed six ounces. It was then digested at a high heat with four pounds of alcohol of specific gravity .837 for two hours, filtered, and again digested with two pounds more of alcohol, which, when separated by a second filtration, was added to the first. Being put into a retort, five pounds of the alcohol were distilled off, and the rest of the liquor evaporated carefully to dryness. It weighed two drams, was of a red-brown colour, with brilliant points throughout it. Its taste was sharp and styptic. It was *soluble in water*, and its odour was like that of rhubarb.

This preparation is recommended in pharmacy as being of constant quality, of convenient solubility in water, and deprived of its inert and ligneous matter; one or two grains is sufficient for a dose.—*Bib. Uni.* xxii. 232.

26. *Change of Fat in Perkins's Engine, by Water, Heat and Pressure.*—Mr. Perkins uses in his steam cylinder a mixture of about equal parts of Russia tallow and olive oil to lubricate the piston and diminish friction. This mixture is consequently exposed to the action of steam at considerable pressure and temperature, and being carried on by the steam, it is found in the water giving rise to peculiar appearances.

The original mixture is solid at common temperatures, but fuses at about 85°. Fah. When boiled in alcohol, a small portion dissolves.

The water, as it issues from the end of the ejection-pipe into the tub placed to receive it, and from which it is pumped up again into the generator, appears white and translucent, and after having been used some time, very much resembles thin milk. A scum is found floating on it, which, when collected together, forms a soft solid, but when it has been long exposed to the action of the steam and at a high temperature, is hard like wax nearly. It is always black and dirty. A portion of this substance was digested in hot alcohol, and the clear solution set aside; flocculi separated in abundance from it on cooling, which, when dried, collected, and fused, gave a grayish substance, contracting and cracking as it cooled, with the lustre and appearance of wax, but rather more brittle. It does not melt in boiling water, but at a higher heat melts, and ultimately burns like fat. It is rather lighter than water; it dissolves readily in alkalies, more readily, I think, than fat, and in this respect resembles Chevreul's acids of fat, as well as in its solubility in alcohol; the alkaline solution is turbid. It is not soluble in ether, or very slightly so; when burnt it leaves an ash consisting principally of carbonate of lime.

The cold alcoholic solution, on evaporation, left a substance similar in many respects, but much softer, even fluid. It burnt in the same manner, leaving a slight ash of carbonate of lime. The merest trace of copper was found in these substances.

The action of the alcohol being continued, nothing at last remained but dirt and mechanical impurities. The softer portions from the surface of the water were found to contain a quantity of unchanged fat and oil.

The milky water, on examination, was found to be a mixture, probably, of this substance and water. It undergoes no change in appearance when left for many weeks, but when filtered through good filtering paper, the latter portions came through clear and transparent, the altered fat being separated. When evaporated it leaves a substance having all the properties of the solid matter above described. The finely-divided state of the substance, its solidity, and its near approach to the specific gravity of water, will, perhaps, account for the length of time during which it will remain uniformly diffused through it.

27. *On Eritrogene, and the colouring Matter of the Blood. By* B. Bizio.—A person afflicted with the yellow jaundice, died in the hospital at Venice, in June, 1821. During an anatomical examination, there was found, in place of bile, a fluid which possessed none of the characters of that secretion. It was in consequence given to Il Sig. B. Bizio for examination, who, finding it to be

of great interest, from the presence of a new animal substance contained in it, and the illustrations it afforded of the colouring matter of the blood, read an account of it to the Atheneum at Venice, from which account this abstract has been made.

The contents of the gall bladder were not of uniform consistence, but consisted of a clot of filaments in a tenacious liquid as thick as honey; the fluid part was of a purple colour; the clot white, with red and black spots; the odour was like putrid fish; it caused no bitter sensation on the tongue; it was rather lighter than water; it did not alter by standing for two or three days.

By decantation and washing, the insoluble portion was separated from all that was soluble in water; it was then heated with water, and agitated, by which means the adipose portion separated, and collecting on the surface, was taken off when cold, and dried by bibulous paper. It was of a greenish colour, and had the odour of the bile originally; the fibrous matter freed from fat, collected at the bottom of the vessel. Being heavier than water, it had lost its original elasticity, and did not act on turnsole or violet paper; upon trial it was found to be fibrine but little altered; the fatty matter, on examination, gave stearine and elaine, which was separated by gently heating the substance in alcohol; the part left undissolved, was of a fine green colour, and being boiled in fresh alcohol, formed a green solution, which by partial evaporation and cooling, yielded rhomboidal crystals, transparent, and of an emerald green colour. This was considered as a new substance, and called *Eritrogene*.

The portion soluble in water, on careful examination, gave colouring matter identical with that of the blood, albumen, a green resin, a yellow substance, salts, *&c.* The composition of the bile is given as

Water	51.232
Stearine	8.613
Elaine	3.972
Eritrogene	4.157
Fibrine	11.348
Albumen	7.282
Colouring matter of blood	3.148
Green resin	2.030
Yellow matter, *&c.*	3.915
Salts, loss, *&c.*	4.303
	100.

Eritrogene.—This substance is of a green colour, tasteless, having the odour of putrid fish; it is transparent, flexible, unctuous, easily scratched or cut, and crystallizes in the form of rhomboidal parallelopipedons; it has no action on turnsole or violet, specific gravity 1.57; it fuses at 110° Fahrenheit, appearing like an oil; when slowly cooled, it crystallizes on solidifying; if heated up to 122° Fahrenheit, it volatilizes giving, in contact with the atmosphere, a purple vapour; its

name was given in consequence of the power it possessed of being transformed into a red matter, and of giving a purple vapour; it does not dissolve in water or ether, but in alcohol with facility; it combines with oils, one-sixth only making them as thick as butter; boiled, or otherwise treated with potash or soda, it does not enter into combination, but merely becomes of a yellow tint, hard and fragile.

Sulphuric acid, when cold, dissolves it without alteration; slightly heated strong effervescence commences, which at first diminishes, and afterwards increases the temperature. When the action has ceased, the *eritrogene* is found altered to a fragile substance of a cinnamon colour. Cold muriatic acid dissolves it also without alteration; when warmed, there is effervescence, and a deep chesnut-coloured butyraceous substance is produced. The cold nitric acid solution of it is green, but at 80° or 90° Fahrenheit, the colour begins to disappear; and at 100° Fahrenheit, is entirely lost. A singular phenomenon then occurs; beyond the limit mentioned the solution begins to appear of a rose tint, which increases by degrees till it arrives at a beautiful purple; as the tint becomes apparent so also does a slight degree of effervescence, which augments with the augmentation of colour and temperature, until both are at their height together about 144° Fahrenheit, when the ebullition ceases, and the matter formed seems to undergo no further change. The gases liberated during the action, proved to be, for the most part, pure oxygen, whence M. Bizio concluded, that the *eritrogene* had taken nitrogen from the acid.

Surprised by this circumstance, and anxious to confirm its singular affinity for nitrogen, M. Bizio acted on the substance by ammonia. A few grains were put with liquid ammonia into a small flask. The action was very slow, and it was only after some days that solution began, and it was without change of colour; but, on heating the flask, strong effervescence began as soon as the eritrogene was fused, and the full purple colour appeared; and on collecting the gases liberated during the action, they were found to consist of ammoniacal and hydrogen gases mixed together. By filling a bent tube with ammoniacal gas over mercury, introducing a few grains of *eritrogene*, and heating them, the purple substance was obtained, and the decomposition of gaseous ammonia as well as that in solution fully proved.

Eritrogene combines readily with sulphur, either by heat or friction; the compound fuses readily at 20°; if heated in the air, the *eritrogene* attracts nitrogen, and leaves the sulphur. It combines also with phosphorus when heated with it under water.* Heated in a tube over mercury with oxygen gas, there was at first but little effect; but the temperature being raised in a dark place, a beautiful phosphoric light appeared, which continued until the whole of the *eritrogene* was changed into a colourless oily fluid, slightly turbid and free from acid. With hydrogen gas, it underwent no change. When

left in the air, it slowly attracts nitrogen, and becomes of a rose colour, but if left too long, it blackens and becomes mouldy. If then put into water, it resumes it spurple colour, and when, by standing, it has fallen to the bottom, the water has a chesnut brown tint, from which, some foreign matter is suspected to give colour to the *eritrogene*, and the pure substance is supposed to be colourless.

Until now, nothing has been said of the nature of the *azotated eritrogene;* but M. Bizio at last states it to be precisely the same substance as the colouring matter of the blood, having presented, on the most scrupulous examination, all the physical and chemical characters belonging to that body.

In some further remarks upon the coloration of the blood, M. Bizio states his opinion, that *eritrogene*, or something very like it, and ready to become *eritrogene*, exists in the chyle; and that, when this reaches the lungs, nitrogen is absorbed as well as oxygen, and colour given to it. He remarks, that though he had been unable to find *eritrogene* in the chyle, yet the researches of Vauquelin, Brande, Marcet, Emmert, Dupuytren, c., have shewn, that a fatty matter, soluble in alcohol, exists in the chyle, and that chyle may be considered, as Thenard has said, blood minus the colouring matter, and plus the fatty substance. Marcet remarks, that the coagulum of chyle is opaque, and has a rose tint, perhaps due to some particles of eritrogene azotated by the air. The author, however, supports his opinion with modesty, and hopes, that ere long, further light will be thrown on this subject.—*Gior. di Fis.* vi. 446.

28. *Compounds of Cystic Oxide.*—The following is the composition as ascertained by M. J. L. Lassaigne, of certain compounds of cystic oxide. Its compound with muriatic acid is crystalline, but always distinctly acid: when dried in the sun, and decomposed by carbonate of ammonia, it gave

Cystic oxide	94.7	100.
Muriatic acid	5.3	

The compound with nitric acid crystallized in needles with a brilliant nacreous aspect. It gave

Cystic oxide	96.9	100.
Nitric acid	3.1	

The sulphate of this substance is a viscid colourless substance, soluble in water, and uncrystallizable. It appeared to be composed of

Cystic oxide	89.6	100,
Sulphuric acid	10.4	

but it was probably not quite dry.

The oxalate crystallizes in needles, which effloresce in the air, it contains

Cystic oxide	78
Oxalic acid	22

The cystic oxide is insoluble in the other vegetable acids. Being analyzed by combustion with oxide of copper, it gave as its elements,

Carbon	36.2
Nitrogen	34.
Oxygen	17.
Hydrogen	12.8
	100

Ann. de Chim. xxiii. 329.

29. *On Prussian Blue in Urine, by* Dr. Julia.—A gentleman of sanguine temperament, aged eighty-two, was attacked with an acute disease of the urinary passages. He had previously enjoyed perfect health. On the second day of the disease, the urine was of a deep blue colour, glutinous, frothed on agitation, and deposited blue filaments. Dr. Sernin, who attended this gentleman, sent a portion of the urine to M. Julia for examination, and the latter ascertained that it contained very little urea, was charged with albumen and gelatine, and that the blue colour arose from hydrocyanate of iron, probably in the form of a triple salt with soda. The cause of the solubility of the substance in the urine is unknown at present.—*Archives Generale.*

30. *Excrement of the Boa Constrictor, Urate of Ammonia.*—Professor Pfaff states, that the excrement of the Boa Constrictor contains so much ammonia as to be a suburate of ammonia. When distilled with weak solution of potash, ammonia is condensed in the receiver; uric acid so treated, yields no ammonia. When evaporated with nitric acid to a certain point, before the formation of purpuric acid, the solution deposits crystals of nitrate of ammonia; if all these be separated, no purpuric acid is furnished by further evaporation, but if allowed to remain, the purpuric acid is produced.

31. *Prize Questions.*—The following prize questions are offered by the Royal Academy of Sciences at Paris.

"To determine by a series of chemical and physiological experiments. What are the phenomena which succeed one another in the digestive organs during digestion?" For the year 1825, the reward a gold medal of 3000 francs value.

"To determine, by various experiments, the density which liquids, and especially mercury, water, alcohol, and sulphuric ether, acquire by compression, equal to the weight of several atmospheres; and to measure the quantity of heat produced by such compression." For the year 1824, the prize a gold medal of 3000 francs value.

III. Natural History.

1. *Extraordinary formation of Hornstone.*—Professor Jameson in some speculations in regard to the formation of opal, woodstone, and diamond, gives the following statement:—" Like opal, hornstone seems sometimes to be a product of vegetable origin, for the specimen which I now exhibit to the Society is a variety of woodstone. This remarkable specimen, which is eighteen inches long, five inches thick, and eight broad, was torn from the interior of a log of teak wood, (*tectona grandis,*) in one of the dock-yards at Calcutta. The carpenters on sawing the log of teak wood, were *arrested in their progress by a hard body, which they found to be interlaced* with the fibres of the wood; and, on cutting round, extracted the specimen now on the table. This fact naturally led me to conjecture, that the mass of woodstone had been secreted by the tree, and that, in this particular case, a greater quantity of silica than usual had been deposited; in short, that this portion of the trunk of the tree had become silicified, thus offering to our observation in vegetables, a case analagous to the ossifications that take place in the animal system. I was further led to suppose that the wood might contain silica in considerable quantity as one of its constituent parts, a conjecture which was confirmed by some experiments made by Dr. Wollaston. Other woods appear also to contain silica, and these, in all probability, will occasionally have portions of their structure highly impregnated with silica, forming masses which will present the principal characters of petrified wood. Indeed, I think it probable that some of the petrified woods in cabinets are portions of trees that have been silicified by the living powers of the vegetable and not trunks, or branches, which have been petrified or silicified by a mere mineral process."—*Edin. Jour.* ix. 165.

2. *Matrix of the Brazilian Diamond.*—In Mr. Hewland's splendid collection there is a Brazilian diamond, imbedded in brown iron ore; another also in brown iron ore, in the possession of M. Schuch, librarian to the Crown Princess of Portugal; and Eschwege has in his own cabinet a mass of brown iron ore, in which there is a diamond in a drusy cavity, of a green mineral, conjectured to be arseniate of iron. From these facts he infers that the matrix, or original repository of the diamond of Brazil, is brown iron ore, which occurs in beds of slaty quartzoze micaceous iron ore, or in beds composed of iron glance and magnetic iron ore named by him *Itabirite,* both of which are subordinate to what he considers as primitive clay slate.—*Edin. Jour.* ix. 202.

3. *Native Carbonate of Soda in India.*—Captain John Stewart being, in the course of military operations, encamped on the banks of the Chumbul, near the village of Peeplouda, just where the

Chaumlee and Chumbul join, had occasion to observe the production of this alkali in considerable quantities in the bed of the river. It being the dry season there was scarcely any stream, but a number of pools, and walking amongst them, "I observed that, on the margin of one of the above pools, the ground for a considerable space appeared beautifully white; on examining it closely, I found it covered with a fine pure saline efflorescence, in general about two or three tenths of an inch in depth, covering a soft, wet, and slippery mud; the taste and appearance of this salt induced me to conclude it was carbonate of soda, which I found to be the case on taking some of it to my tent." Before Captain Stewart could ascertain the extent of the bed, an order came for removal; but he believes there are numberless places in the bed of the river besides the one he discovered, and thinks they might be easily and profitably worked in the dry season. The banks of the river are described as steep and broken, and composed of a kind of friable clay-rock, mixed with loose limestone. The bed of the river is in many places basaltic rock, sometimes forming a smooth surface, exhibiting the pentagonal form of the columns like a regular pavement.—*Bombay Trans.* iii. 53.

4. *Acid Earth of Persia.*—An acid earth is found in great quantities at a village, called Daulakie, in the south of Persia, between three and four days' journey from Bushire, on the Persian Gulf. It is used by the natives in making their sherbets, *&c.*, and large quantities are thus employed. A portion has been brought from thence by Lieutenant-Colonel Wright, and examined by Mr. Pepys, who finds that about a fifth of it is soluble in boiling water, yielding an acid solution, which, when tested, gave proofs of the presence of sulphuric acid and iron, and on evaporation yielded crystals of acidulous sulphate of iron.—*Phil. Mag.* lxii. 75.

5. A most extraordinary experiment has been made by M. Dobereiner. It was communicated to me by M. Hachette, and having verified it, I think every chemist will be glad to hear its nature. It consists in passing a stream of hydrogen against the finely divided platina, obtained by heating the muriate of ammonia and platina. In consequence of the contact, the hydrogen inflames. Even when the hydrogen does not inflame, it ignites the platina in places; and I find that when the hydrogen is passed over the platinum in a tube, no air being admitted, still the platinum heats in the same manner. What the change can be in these circumstances, M. Dobereiner has, no doubt, fully investigated; and the scientific world will be anxious to hear his account of this remarkable experiment, and the consequences it leads to.—M. F.

6. *Organic remains in Poland.*—In a calcareous rock of the moun-

tain of Provislava, in Poland, and at the depth of ten ells, has been discovered a back-bone of the great length of twelve ells. It is now under scientific examination, and an account of the organic remains with its site is promised.

7. *Charcoal in the Cinders of Vesuvius.*—M. Vauquelin stated to the Academy Royal des Sciences, that he had found charcoal in the cinders thrown out from Vesuvius during the last eruption.

8. *Observations made on Vesuvius and its Products.*—An account has been published by MM. Monticelli and Covelli of Naples of the phenomena presented by Vesuvius, in the years 1821-22. It abounds with interesting facts and observations, several of which we are induced to select at this time, from the abstract given of the work in the *Bibliothéque Universelle*, xxiii.

Examination of recent Lava.—On the 11th Feb. Vesuvius began to emit much smoke, scoria, *&c. &c.*; on the 22nd about an hour and a half after sunrise an eruption commenced, and soon after, a current of lava descended from the top of the mountain, and moved over that of 1810, forming a cascade of fire; this current was renewed by others thrown out from the mountain, and attended by all the phenomena of a magnificent eruption. On the 24th MM. Monticelli and Covelli visited the lava to make their experiments. Being covered by cooled scoria, it did not appear in any part to be ignited, but it moved on a nearly horizontal soil, at the rate of 15 feet in 34 minutes. At about 12 feet from the lava the thermometer stood at 93° F., whilst in the free air it was 59° F., but at three feet distance it could not be measured, far surpassing that of boiling water.

Nitre in powder thrown into the crevices of the lava fused without detonating or scintillating. The atmosphere about the lava was not in an electric state, and a chemical examination proved that the lava taken whilst still glowing, contained no free acid, but only some substances soluble in water, amongst which were muriatic acid, sulphuric acid, and lime.

The vapours exhaled by the lava, had no action on paper tinged by turnsole or syrup of violets, they appeared to be composed of steam, with a very small quantity of salts of iron and copper. The vapours had no other effect on the neighbouring lava than to change its colour. The saline efflorescences which deck the surface of the lava with the most brilliant colours, only appear when the lava cools, and when the vapours previously disseminated over the whole surface, concentrate into small fumaroles. These efflorescences which have been erroneously considered as sublimations appear to have existed ready formed in the lava, they were mixtures of chloride of sodium, muriate of iron, and peroxide of iron, as well as carbonate and sub-carbonate of soda, sulphate of soda and of potash.

With regard to the presence of sulphur and sulphurous acid in the

volcano and its lavas, the latter was soon found in the fumes from the crater, and also from the fumaroles in the lava, but on continuing their researches these philosophers were led to conclude, that the sulphurous acid is not contained ready formed in the lava, but is developed by the contact of the air; fragments of red-hot lava plunged into tincture of turnsole, not changing its colour, whilst those which had been cooled in the air easily turned it red.

Sulphur in crystals is not found in the crater. It is requisite for its production that the temperature of the surface of the crater or of the lava should be below 212° F. The sulphurous acid only appears when the temperature is sufficient for the combustion of the sulphur, and the contact of the external air is necessary to its production. Thus the distinction of volcanoes into two classes, namely those which with Vesuvius, produce muriatic acid, and those which with the Solfaterra, produce sulphurous acid is unfounded; since the two acids appear at Vesuvius according to the temperature, and since the Solfaterra does not really produce sulphurous acid, as has been till now supposed, but muriatic acid free and combined, carbonic acid, and sulphuretted hydrogen.

The lava which flowed from the crater on the 26th Feb. was of a deep bluish-grey colour, and a fine grain resembling basalt; it was composed of grains of pyroxine as large as a hemp seed, crystals of amphigine, mica in very brilliant small plates, olivine? in transparent and yellow grains, but rare, and finally of portions of a black pumice as big as nuts and incorporated with the lava.

Volcanic Electricity.—In October of the same year the mountain again became active, and an eruption took place one of the most disastrous that Vesuvius ever gave rise to. After frequent ejections of ashes, &c. from the summit, earthquakes, &c., the lava appeared about mid-day of October 21, 1822, on the border of the crater, and came down in two streams. On the 22nd an enormous column of fire 2000 feet high, rose from the top of the mountain, whilst a rain of hot sand, pumice stones, and lava fell. About 2 o'clock P.M.; the first signs of electricity manifested themselves in that part of the atmosphere situated round the column of sand, which rose from the crater in the form of a pine, and shortly, numberless zig-zag flashes continued without ceasing, to penetrate the cloud of cinders without, however, giving rise to any detonation that could be heard. Towards the evening the thunders commenced just as the volcano took, for a short time, an appearance of repose.

About 8 o'clock our philosophers took the opportunity of the short calm and approached the mountain, just as a fresh and more vigorous eruption took place. Soon the whole heaven seemed on fire from the immense quantity of ignited matter thrown up into it. Towards the middle of the night the paroxysm of the volcano seemed to have risen to its height, but whilst the operations of the crater became more and more feeble, the play of electricity, which embellished the elevated region of the clouds of sand, became stronger

and acquired fresh vigour. At this moment the heavens presented a very unexpected scene; zig-zag flashes of lightning passed in such quantity either from the borders of the clouds of sands into the air, or from one cloud to another, that the edges appeared as if surrounded by a fringe of light. A faint idea of the phenomenon may be given by supposing an electric disc continually throwing off from its edge a multitude of flashes of light. The flashes which were so abundant on the edges of the clouds were very rarely seen in the interior, and never formed in their centres, or on the summit of the mountain.

On the 23d, a horrible explosion threw into the air such an immense quantity of sand, &c., as to threaten the greatest disasters to the towns to which the cloud was carried. The inhabitants of Torre Annunziata, Bosco-trecase, and Ottajano, ran the most imminent dangers; the frequent heavings of the earth, the constant rain of fiery stones, the continual discharge of the lightning, which fell with awful thunder on the most elevated points of the churches, houses, and trees, the numberless flashes which serpentining on all sides, and which not coming less frequently from the earth than from the heavens, traversed even the very roads, produced frightful sensations in those who were thus surprised; and then the lava came down upon them. To leave their houses was impossible because of the falling sand and stones, and the lightning; not only the rain of fire covered the ground with stones, but large globes of fire passed through the air, which burst with dreadful noise, destroying the houses. During this night the sand fell in the streets to the depth of a foot, and its weight on the roofs of the houses and churches was such as with the shaking of the earthquakes to crush them to the ground.

MM. Montecelli and Covelli found that the sand which fell on the 23d and following days was electrified vitriously or positively. A glass disc strongly excited by the dry skin of a cat, would not retain the grains which fell, whilst a stick of wax excited by the same skin became abundantly charged with them. These falls of sand were accompanied at Resina and even at Naples by a strong odour of muriatic acid and muriate of iron.

Eruption of Vesuvius, October 1822.—M. Montecelli had remarked that the eruptions of Vesuvius consisted of a successive series of more and less active intervals, something similar to the paroxysms of some diseases. The following table and remarks illustrate the duration and nature of these intervals with regard to the eruption in October.

Paroxysm	Commencement h.	Conclusion h.	Duration h.
1	Oct. 20, 10 P.M.	Oct. 22, 1 A.M.	27
2	22, 1 A.M.	22, 1 P.M.	12
3	22, 1 P.M.	22, 8 P.M.	7
4	22, 8 P.M.	23, 1 A.M.	5
5	23, 1 A.M.	23, 2 P.M.	13
6	23, 2 P.M.	24, 8 P.M.	30
7	24, 8 P.M.		indefinite.

Effects 1. Much smoke, small streams of lava not passing the foot of the great volcanic cone.

2. Rupture of the eastern lip of the crater; column of fire; ejection of lava on the east and west of the crater; small shower of coarse sand.

3. Pine of sand; new jet of lava; small shower of coarse sand.

4. Force of the eruption at its maximum; new explosion with the destruction of the S.E. eminence of the crater; great overflowing of lava from the same side; ignition of the crater; many columns of ignited stones thrown with force into the air; great development of electricity in the clouds of sand.

5. Great eruption of sand; further overflowing of lava; electricity weaker than before.

6. Two pines on the crater; rain of fine red sand.

7. Pine small; small shower of red sand.

On comparing the duration of the paroxysms, it will be seen that the shortest are found in the middle, and the longest at the extremities; but the shortest were the most violent, and the force of the others was inversely as their duration.

9. *Hot Springs at Jumnotri.*—The following account is from Captain Hodgson's relation of his Journey to the Source of the Jumna. The time was April, 1821. "At Jumnotri, the snow which covers and conceals the stream is about sixty yards wide, and is bounded to the right and left by mural precipices of granite. It is about forty feet five inches and a half thick, and has fallen from the precipices above. In front, at the distance of about five hundred yards, part of the base of the great Jumnotri mountain rises abruptly, cased in snow and ice, and shutting up and totally terminating the head of this defile, in which the Jumna originates. I was able to measure the thickness of the bed of snow over the stream very exactly, by means of a plumb line let down through one of the holes in it, which are caused by the steam of a great number of boiling springs, on the border of the Jumna. The snow is very solid and hard frozen, but we found means to descend through it to the Jumna, by an exceedingly steep and narrow dark hole made by the steam, and witnessed a very extraordinary scene, for which I am indebted to the earliness of the season and the unusual quantity of snow which had fallen this season. When I got footing at the stream, (here only a pace wide) it was some time before I could discern any thing, on account of the darkness of the place made so by the thick steam, but having some white lights with me, I fired them, and by their glare was able to see and admire the curious domes of snow over head; these are caused by the hot steam melting the snow over it. Some of these excavations are very spacious, resembling vaulted roofs of marble, and the snow, as it melts, falls in showers like heavy rain to the stream, which appears to owe

its origin, in a great measure, to these supplies. Having only a short scale thermometer with me, I could not ascertain the precise heat of the spring, but it was too hot to keep the finger in it for more than two seconds, and must be near the boiling point. Rice boiled in it but imperfectly. The range of springs is very extensive, but I could not visit them all as the rest are in dark recesses or in snow caverns. The water of them rises up with great ebullition through crevices of the granite rock, and deposits a ferruginous sediment, of which I collected some. It is tasteless, and I did not perceive any peculiar smell. Hot springs are frequent in the Himalaya."—*Asiatic Researches*, xiv.

10. *Shock of an Earthquake at Sea.*—On Sunday, February 10. 1823, at 1h. 10′. P.M. the East India Company's ship Winchelsea, on her passage from Bengal to England, when in lat. 52°. N. long, 85°. 33′. E. experienced a shock similar to that of an earthquake. Every individual was alarmed by a tremulous motion of the vessel, which gave a sensation as if it were passing over a coral rock, at the same time a loud rumbling noise was heard, similar to the rolling of a butt along the deck. The agitation and noise continued two or three minutes. The captain, being in the round-house, looked out at the stern windows, but saw no appearance of any shoal, though, had there been one, it must have been visible, for the water was clear and smooth, and the ship not going more than two knots an hour, it was considered out of soundings at the time. During the continuance of this phenomenon, there was no perceptible commotion in the sea, and the vessel was some hundred miles from any land. This remarkable phenomenon cannot be accounted for in any other manner than by referring it to some volcanic irruption, probably in one of the islands eastward of the bay of Bengal.

The above account is given by Mr. Parson, surgeon, at the time, of the ship in question.—*Med. Rep.* xx. 175.

11. *Aerolite? at Coddenham, in Suffolk.*—A very heavy storm passed one day in July last, over the village of Coddenham, in Suffolk, about half past two, P. M. from the N. E., the rain fell in torrents with some little hail, accompanied with thunder and lightning. One flash was particularly vivid, followed by an instantaneous loud clap of thunder. When the rain abated, a lad returning home, took from out the run of water, beside the road in the street, a round ball, which, to his astonishment, he found to be a heavy stone and very hot, with a strong sulphurous smell. He shewed it to two people in the village, who not only corroborate the boy's statement, but say the surface of the stone became warmer after it had been a short time out of the water, and then gradually cooled. The stone is nearly globular, about seven inches in circumference, and weighs eight ounces, five pennyweights,

and seven grains. The surface is even, of a dark-grey colour, and answers in every respect to the meteoric stones described in *Jameson's Mineralogy*, and *Murray's Elements of Chemistry*.

The above account is taken from the *New Monthly Mag*. ix. 383, but the evidence of the nature of the stone is somewhat uncertain and doubtful.—We put no faith in it.

12. *Direction of Lightning.*—It is said to have been observed, from a series of observations, in Germany, that the general direction of lightning is from east to west, comparatively seldom from north to south. From another series of observations, also made in Germany, it is stated to appear, that most of the lightning rises in the west and extends towards the east. We suppose it is meant that the direction of the lightning is parallel, or nearly so, to a line running east and west, for whether it goes in the one or the other direction, would, considering its velocity, be a difficult thing to determine. Perhaps, however, it is meant that the place from whence the lightning arises in a storm, is successively removed from east to west, or west to east.

13. *Observations on the Boletus Igniarius, by* Professor Eaton.—Few persons take the trouble to watch the growth of cryptogamous plants, therefore, accidental observations may with propriety be preserved. The *boletus igniarius*, or the common touchwood, is a very durable fungus. We often observe it full grown, and generally several years old; but few persons have observed its progress while in the growing state. A fungus of this species first appeared growing from the trunk of a decaying Lombardy poplar in my yard, about twelve inches from the ground, in July, 1821. During that season it grew to the extent of four inches in diameter. Last June it commenced growing again, and about the 1st September following, it was fifteen inches in diameter, measured across the base of the semicircle. The first season it approached a globular form, though it was an unfinished, and rather shapeless, mass. Now it has assumed its regular form, and seems to have completed its growth, which, if correct, proves it to be a biennial plant.

The most remarkable fact observed in the growth of this fungus, was its flesh-like property, manifested when its parts were severed. A deep gash was cut in its periphery, in August, and the severed parts shortly after united by the process which surgeons denominate first intention. A piece was broken from another part in the same month, and after lying on the ground two days it was joined on again. The piece united, as in the case of the incision before mentioned, and continued to grow with the other parts of the fungus. Now there is not even a cicatrice, nor any other evidence left of the incision or the fracture.—*Silliman Journ*. vi. 177.

14. *On the employment of Electricity in the treatment of Calculous cases, by* MM. Prevost and Dumas.—These philosophers have, in

the course of their researches, thought on the practicability of operating on the calculus in the bladder by electricity, so as either to extract it, or assist in reducing it to that state in which it could be voided without having recourse to an operation.

The modes of applying the electric current are two. It would be possible, in fact, to *extract* the calculus by means of a double sound communicating at one end with the bladder, and at the other with two vessels filled water, into which the poles of the pile should be plunged. This method, if practicable, would transfer the acids and bases of the calculus into the vessels, but it would require a battery of strong power, and probably, from the dispersion of the galvanic fluid, disturb the bladder, which, with other objections, make the method inapplicable. The other mode is, in place of endeavouring to extract the calculus, to aim rather at its disintegration, and bring it into so friable a state that it may readily be broken down, and pass out through the urethra.

A fusible calculus was submitted to the action of a pile of 120 pair of plates for 12 hours, the pile being recharged each hour. The calculus was placed in a vessel of pure water, and the platina wires from the poles of the battery, which also passed through the water, touched it in two points, distant about 6 or 8 lines. During the action, the phosphoric acid, and the bases separated at the poles, then re-combined and fell as an insoluble powder to the bottom of the vessel. At first the calculus weighed 92 grains, but was then reduced to 80 grains; the treatment being continued for 16 hours more, the calculus became so friable, that the slightest pressure broke it into numerous crystalline grains, the largest not larger than a lentil, all of which would easily have passed the urethra.

The practicability of this mode of treatment is evident to those, at all acquainted with physiological experiments. It is almost always possible to carry two conductors into the bladder, which, by means of a slight spring, shall have their extremities separated, so as to touch the calculus in two points. The voltaic current being passed, the calculus would be decomposed without the bladder being too much affected. To prove this, such a system of conductors were introduced into the bladder of a dog, and connected with a battery of 135 pair of plates. It was found that, the bladder being distended by warm water, the animal was not particularly disturbed, notwithstanding the conductors decomposed water with energy, and gave torrents of gas.

The following experiment was then made: a fusible calculus was fixed at the end of the sound, between the two conductors, and introduced into the bladder of a large dog, which was then filled with warm water. The conductors were then connected with the battery. After some slight movements, the animal became calm, and remained quiet under the galvanic action for an hour. The sound being carefully withdrawn, the calculus was found decidedly to have undergone decomposition. This was repeated for six days, one hour

night and morning, when the calculus had become so friable, as to oblige the discontinuance of the experiment. It had lost in weight like the former calculus. After some days' rest, the dog was killed, and the bladder examined; its texture was just as usual, its appearance presented nothing particular, and when opened for the evacuation of the urine, its fibres contracted just as usual.

The innocuous nature of such a voltaic current on an organ, at a certain distance from it, may be readily ascertained in the following manner: place the conductors and calculus in the water, as in the first experiment, then pass the current, and also dip the tongue into the water; it will be found that whilst the calculus is undergoing rapid decomposition, the tongue, sensible as it is to the influence of electricity, will scarcely be able to ascertain its presence, when not more than 15 or 18 lines from the calculus.

It is evident that this process will be of no avail in the treatment of calculi, composed of, or containing much, uric acid; and MM. Prevôst and Dumas do not think of recommending the process in cases even where it promises help, until farther investigation has lessened the difficulties, and illustrated the points which remain untried. They have introduced calculi into the bladders of dogs; and when the wounds have cured, propose practising on them, that the best method for the human being may be ascertained. It will be requisite to ascertain, by experiment, what fluid will be best for the distension of the bladder; and it is indispensable to find means of ascertaining accurately the nature of the calculus whilst in the bladder. They are encouraged against these and other difficulties, however, by having already ascertained, at the Jardin des Plantes, that the action of the pile causes no bad effects on the bladder; and also that the addition of a certain quantity of nitrate of potash to the fluid for injection, renders the decomposition more rapid and sure, so that the hard and compact phosphates give way in an analogous manner to those that are porous.—*Ann. de Chim.* xxiii. 202.

15. *Dumbness cured by Electricity, by* Miles Partington, esq.—The following account of a galvanic experiment on a dumb boy having been inserted in several newspapers, unknown to me at the time, I am induced, by the advice of several medical friends, to attest the truth and correctness of the detail, as far as respects my knowledge of the circumstances attending the event of his recovery; and having made the strictest inquiry of those immediately connected with Christ's Hospital, I have every reason to believe the following detail to be strictly true.

Eighth months ago, a youth about twelve years of age, named Oldham, in Christ's Hospital, went to bed at the usual hour, and in the morning rose totally dumb. He preserved every other faculty, but was obliged to write on a slate for every thing that he wanted, that he could not explain by signs. Every means of internal re-

medy, and also electricity, were resorted to without effect. Galvanism was also attempted, but was so much resisted by the boy's fears that it could not then be applied. His general health was invariably good. At length, by strong recommendation, his fears of galvanism were overcome, and it was applied five different days. On Friday week, being the evening of the fifth application, exactly eight months to a day, he retired to bed as usual, and awoke suddenly about eleven o'clock, making so much noise as to awaken some of his schoolfellows. Their astonishment produced so much alarm that the nurse opened the door of her adjoining apartment to learn the cause, when many voices exclaimed, "Oh! nurse, Oldham can speak again." The nurse doubting the fact, immediately went to him, and discovered the reality of this phenomenon. In the morning the boy had quite recovered his speech, and on being asked if he felt any peculiar sensation, merely said, he thought he was being galvanised, as he felt the tip of his tongue affected, together with a rumbling in his inside. His speech has continued perfect ever since.

In addition to the above statement it may be proper to say, some time previous to the commencement of the experiment, he was brought to my house, but having been somewhere electrified, the boy was so much frightened, on seeing a large apparatus in the room, that, considering the agitation he then laboured under, I did not think it prudent to urge him further, and he departed without being galvanized. About two or three months after he came again, attended by a medical assistant, with a note from Mr. Field, the respectable apothecary to the Hospital, assuring me that the boy was willing to submit to the experiment, and to be repeated according to my direction; and, in truth, he suffered me to proceed in a willing manner. I began with a small galvanic trough, plates in breadth and depth one inch, with diluted muriatic acid. Having placed a piece of insulated platina on his tongue, which, holding in his own hand, he could shift according to instruction, while I applied another conductor to different parts of the larynx, varying the direction according as I perceived the muscles to be most easily put in motion, and the vocal nerves apparently excited. By the account he gave after his recovery, a sensation of warmth always continued for some time as he returned home, and there constantly occurred an increased flow of saliva during the operation.

I am not aware that any further particulars are necessary to be stated, as every person conversant with the medical application of galvanism or electricity, must know the necessity of attending to the present sensations, as a guide which admits of variation according to the state or temperament of the sensory nerves at the time of application. I deem it only necessary to add, that my young patient attended three days in the week, and it was on the morning after the fifth time that I received a grateful letter from the father, informing me of his son's entire restoration of speech at 11 o'clock on the preceding night, having been galvanized at 3 o'clock on the same day,

being the fifth time of attendance, and I was much gratified a few hours after with a visit from the boy, attended by his father, the son himself giving me, with a clear voice, the whole of the circumstances stated in the Times newspaper, and, as I am told, copied afterwards into other papers.

P. S. It may be proper to state, the boy continues well at the present time.

Orchard-street, Portman-square, June 19, 1823.

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1. *The Greenwich Mural Circle.*—Feeling a lively interest in any thing connected with the Royal Observatory, we have, with the greatest satisfaction, seen the results of Mr. Pond's inquiry into the state of the Greenwich mural circle: the experiments prove almost to a mathematical certainty, that this splendid instrument is, after twelve years constant use, as free from error, as even its warmest advocates, or the most accomplished observer, could wish.

2. *Mr. Groombridge's Transit Circle.* — Whilst admiring the mechanical skill of him who constructed the Greenwich mural circle, we were much concerned to hear, that there were some grounds to suspect the accuracy of another instrument made by the same artist, and generally considered, little inferior to the Greenwich circle itself; we allude to the four-feet meridian transit circle, late the property of Mr. Groombridge. On this gentleman's retiring from the duties of an active observer, the instrument was disposed of, liable however, to an examination on the part of its maker, as to its efficiency or inefficiency; which investigation being conducted by Mr. Troughton, in the presence of Mr. Groombridge, the late Professor Tralles, and its intended purchaser, gave reason to fear that some alteration in its figure, had been sustained. Accordingly, future and more minute examination was deemed necessary; and, at length, it was resolved, that comparisons of North polar distances taken on the same nights, with it and the Greenwich mural circle should be entered into; and the results of many weeks' observations proved, that those obtained by Mr. Groombridge with *his* instrument, were, to use the words of the Astronomer Royal, " as coincident with those procured by the Greenwich mural circle, as those of the Greenwich mural circle were with themselves." Knowing that the reports of the suspected inaccuracy have extended far and wide, we feel it due to Mr. Troughton who constructed the instrument, and to Mr. Groombridge, who used it, to give publicity to the above statement. It is at present in Blackman street, and is having eight additional microscopes applied by Mr. Troughton; it will then have six readings to each of its divided circles, so that all error of division will probably be annihilated. We hope ere long to see it actively employed.

ART. XIII.—METEOROLOGICAL DIARY for the Months of June, July and August, 1823, kept at EARL SPENCER'S Seat at Althorp, in Northamptonshire.

The Thermometer hangs in a North-eastern Aspect, about five feet from the ground, and a foot from the wall.

For June, 1823.

		Thermometer		Barometer		Wind	
		Low	High	Morn.	Eve.	Morn.	Eve.
Sunday	1	45	75	30.07	30.00	W	WbN
Monday	2	55	72	29.73	29.59	W	SW
Tuesday	3	46	65	29.49	29.46	W	WbS
Wednesday	4	44	64	29.34	29.42	SW	W
Thursday	5	40	64.5	29.44	29.48	SW	SW
Friday	6	40	67	29.70	29.80	NNW	W
Saturday	7	39	66	29.90	29.86	W	SW
Sunday	8	48	65	29.86	29.79	W	W
Monday	9	49	64	29.79	29.79	W	NW
Tuesday	10	40	65	29.85	29.85	NW	NW
Wednesday	11	42	66	29.95	29.93	NW	NW
Thursday	12	41	67	29.93	29.90	NNW	NNW
Friday	13	38	69	29.83	29.77	NW	NW
Saturday	14	55	69.5	29.80	29.82	NNW	NW
Sunday	15	58	67	29.88	29.98	NW	ENE
Monday	16	41	67	30.18	30.18	NE	NE
Tuesday	17	40	69	30.20	30.17	NW	NE
Wednesday	18	46	56	30.14	30.10	NbE	NbE
Thursday	19	49	61	30.09	30.05	NbE	NE
Friday	20	47	66	29.99	29.95	NE	NE
Saturday	21	44	56	29.98	30.00	NE	NE
Sunday	22	46	57	30.03	30.03	NbE	NbE
Monday	23	39	58	30.00	29.92	NE	NW
Tuesday	24	44	[illegible]	29.82	29.78	W	W
Wednesday	25	[illegible]	68	29.65	29.58	WSW	SW
Thursday	26	45	[illegible]	29.51	29.48	WbS	WbS
Friday	27	[illegible]	[illegible]	29.21	29.17	E	WbS
Saturday	28	[illegible]	70	29.19	29.20	WbS	WbN
Sunday	29	[illegible]	72	29.57	29.64	W	W
Monday	30	45	71	29.85	29.86	W	E

For July, 1823.

		Thermometer		Barometer		Wind	
		Low	High	Morn	Eve.	Morn	Eve.
Tuesday	1	52	69	29.73	29.82	ENE	ESE
Wednesday	2	47	66	29.87	29.89	SW	WbN
Thursday	3	46	65	29.91	29.97	NE	EbN
Friday	4	51	67	29.90	29.80	WSW	WSW
Saturday	5	54	73	29.82	29.70	W	WbS
Sunday	6	59	70	29.60	29.54	W	W
Monday	7	50	67	29.54	29.54	W	WbS
Tuesday	8	47	65	29.54	29.57	W	WNW
Wednesday	9	44	69	29.78	29.82	W	W
Thursday	10	45	72	29.90	29.87	W	SbW
Friday	11	55	70	29.65	29.50	SW	SW
Saturday	12	54	70	29.50	29.55	WbS	W
Sunday	13	59	60	29.60	29.52	S	SW
Monday	14	50	70	29.52	29.63	W	WbS
Tuesday	15	50	66	29.67	29.42	SW	SW
Wednesday	16	49	67	29.43	29.46	SW	SW
Thursday	17	46	66	29.76	29.80	WbS	W
Friday	18	51	66	29.70	29.70	SE	NbW
Saturday	19	48	64	29.79	29.77	WbS	SW
Sunday	20	56	76	29.80	29.80	W	SW
Monday	21	59	68	29.55	29.48	SE	W
Tuesday	22	50	67	29.70	29.71	WbS	W
Wednesday	23	51	66	29.45	29.36	SSW	SW
Thursday	24	52	67	29.58	29.70	W	W
Friday	25	48	62	29.62	29.55	WbS	S
Saturday	26	50	64	29.54	29.60	NW	NW
Sunday	27	46	66	29.73	29.78	NW	W
Monday	28	52	69	29.72	29.70	SW	WbS
Tuesday	29	47	69	29.70	29.68	SW	SW
Wednesday	30	53	70	29.68	29.69	W	W
Thursday	31	50	70.5	29.80	29.88	W	SW

For August, 1823.

		Thermometer		Barometer		Wind	
		Low	High	Morn	Eve	Morn.	Eve.
Friday	1	49	68	29.95	29.92	SW	SW
Saturday	2	55	71	29.88	29.80	SW	WSW
Sunday	3	53	70.5	29.70	29.58	SbE	WbS
Monday	4	52	69	29.50	29.67	WbS	WNW
Tuesday	5	41	67	29.70	29.69	WSW	WbS
Wednesday	6	41	67	29.69	29.67	W	W
Thursday	7	46	66	29.72	29.70	W	SW
Friday	8	44	65	29.70	29.70	SW	WbN
Saturday	9	47	65	29.79	29.90	SW	W
Sunday	10	46.5	68	29.95	29.91	SSE	WbS
Monday	11	58	75	29.88	29.85	WSW	SW
Tuesday	12	61	76	29.79	29.75	WbS	SW
Wednesday	13	58	75.5	29.62	29.58	WSW	S
Thursday	14	55	65	29.50	29.70	SW	WbS
Friday	15	45	64	29.68	29.56	WbS	W
Saturday	16	45	64	29.38	29.39	SW	WbS
Sunday	17	45.5	67	29.72	29.78	W	WbS
Monday	18	48	68	29.78	29.70	SE	SE
Tuesday	19	61	69	29.66	29.67	SW	WbS
Wednesday	20	48	67	29.72	29.70	WbS	WbS
Thursday	21	44	63.5	29.72	29.74	W	WbS
Friday	22	43	60	29.70	29.58	E	NE
Saturday	23	56	66	29.55	29.68	W	W
Sunday	24	54	68	29.79	29.73	E	S
Monday	25	56	75	29.73	29.73	SE	W
Tuesday	26	55	65	29.90	29.88	E	ENE
Wednesday	27	56	71	29.99	30.00	SE	W
Thursday	28	48	73	30.04	30.02	W	W
Friday	29	58	72	29.94	29.96	SW	WbS
Saturday	30	51	68	29.89	29.88	W	WbN
Sunday	31	46	67	30.09	30.09	WbN	W

THE

QUARTERLY JOURNAL,

January, 1824.

ART. I. *A short Account of the Origin, Progress, and present State of the various Establishments for conducting Chemical Processes, and other Medicinal Preparations, at Apothecaries' Hall. (with a Plate.)*

FROM the charter granted to the Society of Apothecaries by his majesty King James the First, it appears that about the latter end of the sixteenth and the beginning of the seventeenth century, the metropolis of this kingdom abounded in ignorant and dangerous empirics, who, not being regularly educated as apothecaries, made and compounded many " hurtful, false, and pernicious medicines," the evil effects of which were not confined to the capital, but were disseminated through most parts of the kingdom. With a view to remedy these grievances the society was established in the year 1617, and was empowered to make ordinances concerning medicines and compositions, advising respecting the same with the president and censors of the Royal College of Physicians; also to examine the shops of apothecaries within the city of London, and to the extent of seven miles around it, with a view of ascertaining the qualities of the drugs and medicines contained in them, and with power to destroy all " unwholesome and hurtful articles' which they might discover during such examination.

It was soon found that the want of legislative authority ren-

dered the wise and judicious intentions of this charter nugatory, with respect to all such apothecaries who were not members of the society. Early and repeated applications were therefore made to parliament, for their sanction to confirm and establish the powers contained in it, but for various causes such sanction could not then be obtained; so that the evils, which it was chiefly intended to obviate in the preparation of medicines, continued to an equal and probably greater extent.

From the records of the society, it appears, that its members soon discovered a laudable anxiety to relieve themselves from the necessity of depending for a supply of medicines on the artifices, and the spurious compositions of the druggists and chemists of that time, and accordingly, in the year 1623, they formed a plan for supporting a dispensary of their own, for compounding the more elaborate confections, (which containing a great number of ingredients were more liable to adulteration) by a public dispensation under the inspection and management of a committee of themselves. The utility of this plan, being probably confined to very few articles, must have been of a very limited extent, and it was not until nearly half a century after, that the design of a public laboratory for the preparation of chemical medicines was set on foot. It originated from the difficulty and great expense which must have been incurred, by the apothecary, in making his own chemicals, and from the impracticability of his procuring them elsewhere in a pure and genuine form.

In the year 1671, a chemical laboratory was first formed at Apothecaries' Hall, by subscription among the members of the society. When compared with the present very extensive establishment, it must certainly have been upon a small scale, but, no doubt, amply sufficient to answer the purpose for which it was then intended, which was to furnish the individual subscribers, and them only, with such chemical preparations as they might have occasion for in their medical practice as apothecaries.

How long the sale of chemicals was confined to subscribers alone cannot now be known, but the increasing reputation of this laboratory must have soon caused applications for purchasing

them from persons who were neither subscribers nor members of the society, for, in 1682, the committee of managers were called upon to consider the propriety of acceding to such applications. Whether it was at that time consented to, or not, does not appear, but it must have taken place within a few years after.

In the early part of the reign of her late majesty Queen Anne, a new era took place in the affairs of this society. So much difficulty had arisen in providing pure and genuine drugs and medicines for the use of the Royal Navy, and the credit of the society in their chemical preparations was so fully established, that application was made to them by his royal highness Prince George of Denmark, Lord High Admiral, to undertake that service, which was readily consented to, and became the origin of a separate commercial establishment under the title of the Navy Stock.

Until this time chemical processes only were carried on at their hall, but as it now became necessary to provide both drugs and their preparations, as well as the various galenical medicines at that period employed, a considerable capital was formed, and warehouses and laboratories erected for that purpose. The great expense attending the establishment of this stock, which, from the extensive erections of such various kinds, became unavoidable, rendered it for the first half century a source of small pecuniary profit to the proprietors. It is only subsequently to that period, that the numerous and extended wars in which the nation has been engaged, and the consequent large supplies of medicines required for the service of the navy, in addition to the great quantities exported to India, by order of the Honourable East India Company, and the large sums which have been of late years received for medicines furnished for public institutions, as well as private families, that a profit has accrued by which the society and its members have been indemnified for the losses and other disadvantages sustained in the infancy of this commercial establishment.

As the concerns of the society have been, at all times, conducted with that accuracy and integrity which has acquired for the medicines prepared at Apothecaries' Hall the highest character both

throughout this kingdom and in almost every part of the globe, it will be right to give a general explanation of the manner in which the business is conducted, subjoining a short description of the present improved state of their laboratories and apparatus, and also of the several processes carried on in them.

The general management of the affairs of the society, as connected with the preparation of medicines, is under the immediate superintendence of committees, who meet four times in the week, or oftener when required, and some member of which attends daily and enters in a book the processes which he finds carrying on at the time of his visit. These daily attendances are performed by the members of the committees in rotation.

The *buying committee* meets every Tuesday at one in the afternoon, to examine and compare the samples of articles sent in by the druggists, and to direct their purchase; the articles wanting, and the quantity of each required, being specified upon a list posted up in the hall for the information of any merchant or druggist who may choose to offer samples to the committee. At these meetings, the best article being selected and determined upon, the chairman announces the name of the vender and the price, and the deputy chairman enters the order. Where two or more samples of the same article are equal in quality but vary in price, the cheapest is purchased; if the price of two or more equally good samples be the same, and the quantity required considerable, the order is generally divided, or given to that house from which the least has been purchased.

In this way every drug and other article required for the use of the society's trade is purchased exclusively by sample.

To ensure the correspondence of the bulk of the article delivered into stock with that of the sample, a distinct *Committee of Inspection* meets every Friday, for the purpose of comparing the bulk with the sample presented on the preceding Tuesday, and rejecting or receiving it accordingly. It is also an important duty of this committee to examine samples of all preparations whatever, coming from the laboratories, previous to their being disposed of in trade; samples, therefore, of all powders, tinctures, chemical

and other preparations, are regularly presented at this committee; and their qualities determined by inspection or experiment, when any faulty articles are rejected or returned for amendment, while those which are approved are entered as such, and ordered into the shops and warehouses.

The immediate business of the chemical laboratories as relates to the processes, operations, and apparatus, are under the control and inspection of the superintending chemical operator; and of the chemical and galenical operators who reside at the hall; and these officers constantly attend the buying and inspecting committees, and such other meetings of the directors of the establishment as may require their presence.

If any explanation be necessary of the prices charged by the Society of Apothecaries for their medicines, which are in some instances higher than those usually affixed to the same articles, even by respectable chemists and druggists, it will be only necessary to observe that the mode in which the business is transacted at Apothecaries' Hall, puts it out of their power to enter into competition with those persons in that respect for the reasons which follow:

The society consider it their duty to countenance and support the laudable designs of the Royal College of Physicians by adhering strictly to the directions of the Pharmacopoeia in the preparation of medicines, both as to the quality of the ingredients and the proportions in which they are employed. Moreover, their practice of purchasing none but select drugs, separated from those parts which are of a damaged or inferior description, compels them to give proportionably higher prices for them than are given by the wholesale trader, who either imports his own drugs, or purchases them in their original packages as imported, which he afterwards garbles and divides according to their respective qualities, and fixes his prices to the different purchasers accordingly.

The medicinal compositions which are most liable to adulteration, because the less easily detected, are extracts, confections, and tinctures. The ingredients of which these are formed, are for the most part very expensive, such as, among many others,

opium, cassia fistula, castor, colocynth, saffron, benzoin, guaiacum, scammony, cinnamon, cardamom seeds, but above all the cinchona lancifolia, or crown bark, which from the very high price it bears, from the large quantity of it which ought to be employed, and from the many inferior sorts of bark which may be purchased in some instances for not more than a sixth part of its price, affords a strong temptation to abuse, both in the quantity and quality of the article made use of; a temptation, which the most charitable judgment must suppose, in many cases, too strong to be resisted.

That there are chemists and druggists in the metropolis, from whom genuine drugs may be purchased, and by whom medicines are prepared with fidelity, is indisputable, but it may be feared that it is too often far otherwise. The advantage of low prices is a powerful inducement with medical practitioners, both in town, and particularly in the country, to purchase inferior medicines; placing that confidence in the vender of them, to which, they are perhaps not aware that he is not always entitled, and of the quality of medicinal preparations the practitioner himself is frequently an incompetent judge.

As superior excellence in the condition of the various materials employed in the preparation of medicines must be allowed to be of the greatest importance, and as it is a trust so liable to abuse, that it must ever be considered highly confidential, it is respectfully submitted that this advantage cannot be satisfactorily secured by any other method than that which has been constantly pursued by the Society of Apothecaries, namely, having no articles of inferior qualities in their possession, and, as far as is practicable, conducting all their processes within their own walls, and particularly that of powdering drugs in their own mills, by which a fruitful source of fraud must be effectually prevented.

After repeated solicitations, the Society have for a few years past, in addition to the general business carried on at their hall, opened a department for the sole purpose of preparing and compounding the prescriptions of physicians and others, which from the success which has already attended it, they are well satisfied will prove an acceptable enlargement of a system, the prin-

cipal object of which, in all its branches, has been to provide the public with pure and genuine medicines.

Description of the Laboratories.

The principal laboratory is a brick building about fifty feet square and thirty high, lighted from above, and subdivided by a brick wall into two compartments, the dimensions of the larger one being fifty feet by thirty; and of the smaller fifty feet by twenty. The former may properly be termed the *Chemical Laboratory*, all the open fires and furnaces being situated in it, and all operations requiring intense heat being there conducted. The latter is usually termed the *Still-House*, all distillations and evaporations being performed there, exclusively by steam, which is furnished in a manner afterwards to be described, by a boiler placed in a small building annexed to the main laboratory.

Immediately connected with the above-mentioned building is a chemical warehouse for such articles as are in immediate consumption in the laboratory, above which is a small house for a clerk, the whole being shut off from the laboratory by iron doors.

The principal entrance to the chemical laboratory is through the *Mortar-room*, which is forty feet long and twenty-two broad, and appropriated to mortars, presses, and generally speaking to all mechanical operations performed by manual labour. At its eastern extremity is a large drying stove, heated by flues, for the desiccation of those articles which cannot be dried conveniently at temperatures easily obtained by steam. At the west end of this apartment a room twenty-two feet by fifteen is divided off, in which is an apparatus for the production of gas from oil, with which the hall and its various departments, both externally and internally, are lighted. Above the mortar-room is a gallery fitted with shelves for various utensils and apparatus, opening at one end into a room appropriated to the use of the labourers, and at the other, into the *Test-room*, a small laboratory fitted up with the requisite apparatus, for minute and delicate investigations, and in which chemical tests and other articles requiring peculiar attention and cleanliness are prepared.

Annexed to the gas-room is a counting-house, behind which a room twenty-two feet square, commonly called the *Magnesia-room*, is appropriated to the preparation of that article, and also to the manufacture of the most common saline preparations.

Such are the general arrangement and dimensions of the various buildings connected with or forming part of the chemical laboratories; in a detached building there is a steam-engine of eight horse power, which is employed with proper machinery, for grinding, sifting, triturating, pounding, and a variety of other operations, which it is not necessary at present particularly to advert to. There are also connected with the establishment, suitable warehouses, shops, and all other requisite conveniencies for carrying on an extensive trade.

In the construction of the new laboratory safety is ensured by the whole being fire proof, and it is ventilated by a series of apertures in the roof, which may be opened or closed at pleasure. The main chimney is erected in the centre, and has, opening into it below the pavement of the laboratory, four large flues, one of which enters upon each side of its square base. The shaft is one hundred feet high from the foundation, and is accessible in its interior from one of the under-ground flues. The flues of the furnaces which are placed against the walls of the laboratory are each supplied with registers, and open into a common channel, which surrounds the building, terminating in the chimney as already described. Each of the four large flues has also a separate register, which may be more or less closed or opened according to the operations which are going on in the various furnaces connected with it. The furnaces thus arranged are,

A subliming apparatus for benzoic acid.

A furnace for the preparation of sulphate of mercury.

A high pressure steam-boiler.

A reverberatory furnace.

A sand bath.

An apparatus for muriatic acid.

Ditto for nitric acid.

Ditto for the distillation of hartshorn.

A calcining furnace.

There are also a series of furnaces built against the sides of the main chimney, and communicating directly with it by flues of their own, which, as well as the common openings by which they enter the chimney, are supplied with effectual registers, so that when not in use they may be perfectly closed. Of these furnaces, four are chiefly employed for various sublimations, and fusions; four are retort pots; the third side of the chimney is occupied by a powerful wind furnace; and the fourth by a furnace for the sublimation of calomel. In this laboratory there is, moreover, a very copious supply of water, both hot and cold; and an engine-hose and pipe is always attached to the water main, in case of accident by fire, as well as for the purpose of cleansing the pavement. Beneath the building are extensive vaults for fuel, with which there is a direct communication by steps descending in one of the angles of the laboratory.

The *still-house* contains six stills of various dimensions and constructions, twelve pans, or boilers, and a drying stove, all of which are exclusively heated by steam, supplied from an eight hundred gallon copper boiler, placed in an annexed building, below the level of the still-house; and the flue of which, passing under the pavement of the laboratories, enters the main chimney already described.

The boiler is calculated to supply steam under a pressure of an atmosphere and a half, and is fed with hot water by a forcing pump kept in constant operation by the steam-engine. It is properly fitted with valves, and pressure and water gauges.

The main steam-pipe, after ascending from the boiler, sends off descending branches which ramify under the pavement of the still-house, in channels of brick-work, covered by cast-iron plates. These send off a steam-pipe, fitted with a register cock, to each still and boiler, from which there passes off an eduction or condensed water-pipe, entering the condensed water main, the ramifications of which accompany the steam main, and deliver their contents into a cistern, whence the boiler is supplied with hot water. A large branch of the steam-pipe circulates in five convolutions at the bottom of the drying stove, so as to heat a cur-

rent of air which is made to pass through it; and another branch, rising perpendicularly through the pavement, is properly fitted with cocks and screws for the occasional attachment of leaden or other pipes, for boiling down liquids in moveable pans and vessels.

In this building, one of the stills is of a distinct construction, and heated by high pressure steam, supplied from the boiler already mentioned in the description of the laboratory. Another still, together with its condensing pipe, is composed entirely of earthenware. The former is chiefly used for the first distillation of sulphuric ether, and the latter for that of spirit of nitric ether. The stills and vessels are generally heated by the circulation of steam upon their exterior, but sometimes serpentine pipes traversing the liquor are employed.

In the still-house all spirits and waters are distilled; extracts and plasters are prepared; and all operations are carried on which involve risk by fire, or in which damage is likely to occur from excess of heat.

The *Magnesia-room* contains proper vats and boilers for the production and evaporation of saline solutions; the apparatus for the precipitation of carbonate of magnesia; and a series of vessels for saturating alkalies with carbonic acid.

In the above outline it has been intended to shew that no labour or expense has been spared to render the chemical laboratories complete, and that all the important modern improvements in their construction have been adopted upon an extensive scale, rather than to enter into any particulars respecting the arrangement and dimensions of the vessels, furnaces and apparatus which they contain. These details will be found in the description of the annexed Plate representing the ground plan of the laboratories. —*See* Plate.

Art. II. *Remarks on the Numerical Changes of the Population of Great Britain, as divided into the Classes of Agriculturists, Manufacturers, and non-productive Labourers, during the period from* 1811 *to* 1821. *By* George Harvey, Esq., M.G.S., M.A.S., *&c. &c.*

[Communicated by the Author.]

The numerical changes which particular branches of a community undergo, in the progress of time, are to be classed among the most remarkable phenomena with which we are surrounded; and may be regarded as the ultimate result of that great chain of causes, which is in perpetual operation to alter and diversify the condition of man. In a society, exposed to the uncertain tide of political events, it is interesting to trace the mutations which some of its greater divisions disclose, as causes, more or less favourable, operate upon them;—how, for example, at one period, or in some particular districts, the manufacturing part of a community increases in numbers, in happiness, and prosperity; and how, at other times, and in other districts, indications of an opposite kind may be traced;—commerce imparting vigour at one season, and at another exhibiting only the feeblest influences of its power. So likewise the condition of an agricultural population changes; and shades of prosperity may be discovered in a singular variety of forms.

Such uncertainties must necessarily impart their influence to population. The principle of *subsistence*, which, without impropriety, may be said to govern and control all the primary movements of man, will operate as a perpetual stimulus, and compel him to migrate from one branch of a society, or from one country to another, until he finds a station suited to his wants.

To this principle may be referred the numerical changes which the three divisions of the inhabitants of Great Britain have undergone, during the period from 1811 to 1821. The divisions here alluded to are those prescribed by the Act for ascertaining the population; consisting, 1°. *of families engaged in agriculture;*

2°. *of families employed in trade, manufactures, or handicraft;* and 3°. *of all other families not included in the other classes**.

The magnitude and character of these changes are exhibited in the following tables: the first presenting the general results relating to England, Wales, and Scotland; the second to the particular conclusions deduced for the counties of England; and the third and fourth to the results obtained for those of Wales and Scotland.

Proportional change of 10,000 Families, chiefly employed

In Agriculture.		In Trade, Manufactures, or Handicraft.		Otherwise than the two preceding Classes.	
		GENERAL RESULTS.			
England . . .	−168	England . . .	+175	England . . .	− 7
Wales	−555	Wales	+ 63	Wales	+192
Scotland . . .	−211	Scotland . . .	+ 33	Scotland . . .	+178
		ENGLAND.			
Rutland . . .	+432	Stafford . . .	+731	Durham . . .	+518
Northampton .	+400	Derby	+609	Worcester . .	+401
Buckingham .	+235	Westmoreland .	+591	York, N. Riding	+343
Salop	+192	Sussex . . .	+563	Norfolk . . .	+283
Huntingdon . . .	+102	Cornwall . . .	+557	Hertford . . .	+252
Oxford	+ 79	York, E. Riding	+539	Devon	+233
Lincoln . . .	+ 69	Monmouth . .	+517	Northampton .	+231
Kent	+ 65	Warwick . . .	+450	Buckingham .	+227
Suffolk	+ 50	Surrey	+425	Cumberland . .	+175
Dorset	+ 49	Lancaster . . .	+121	Chester . . .	+169
Essex	+ 47	Northumberland	+384	Somerset . . .	+169
Southampton .	− 9	Huntingdon . .	+322	Wilts	+168
Berks	− 21	York, W. Riding	+265	Bedford . . .	+133
Westmoreland .	− 22	Cambridge . .	+197	Southampton .	+130
Surrey	− 28	Gloucester . .	+146	Nottingham . .	+120
Cambridge . .	− 36	Berks	+140	York, W. Riding	+ 87
Middlesex . .	− 50	Essex	+132	Kent	+ 72
Devon	− 78	Lincoln . . .	+107	Leicester . . .	+ 72
Hereford . . .	− 88	Leicester . . .	+106	Hereford . . .	+ 30
Somerset . . .	− 89	Cumberland . .	+101	Gloucester . .	− 10
Hertford . . .	−122	Middlesex . .	+ 63	Middlesex . .	− 13
Norfolk . . .	−125	Hereford . . .	+ 58	Suffolk	− 26
Nottingham . .	−128	Oxford . . .	+ 50	Dorset	− 34
Bedford . . .	−128	Durham . . .	+ 49	Lancaster . .	−100
Gloucester . .	−136	Chester . . .	+ 32	Sussex	−103

* In the Act of 1801 relative to the population, the inquiry related to *persons*, and not to *families*. This led, however, to so many ambiguities and uncertainties, that the very accurate author of the Preliminary Observations to the Population Returns for 1821, observes, that it "was found in practice to produce no valuable result." This was corrected in the Acts of 1811 and 1821; and the results now appear to merit considerable attention.

Proportional change of 10,000 Families, chiefly employed

In Agriculture.		In Trade, Manufactures, or Handicraft.		Otherwise than the two preceding Classes.	
ENGLAND continued.					
Wilts	−178	Wilts	+ 10	Berks	−119
Leicester	−178	Nottingham	+ 8	Oxford	−129
Cornwall	−182	Bedford	− 5	Monmouth	−141
York, E. Riding	−186	Dorset	− 15	Salop	−148
Chester	−201	Suffolk	− 25	Warwick	−157
Northumberland	−218	York, N. Riding	− 43	Cambridge	−161
Worcester	−222	Salop	− 44	Northumberland	−166
Cumberland	−276	Somerset	− 80	Rutland	−170
Stafford	−278	Southampton	−121	Lincoln	−176
Warwick	−293	Hertford	−130	Essex	−179
York, N. Riding	−300	Kent	−137	Derby	−233
Lancaster	−321	Devon	−155	York, E. Riding	−353
York, W. Riding	−352	Norfolk	−158	Cornwall	−375
Monmouth	−373	Worcester	−182	Surrey	−397
Derby	−376	Rutland	−262	Huntingdon	−424
Sussex	−460	Buckingham	−462	Stafford	−453
Durham	−567	Northampton	−361	Westmoreland	−569
WALES.					
Cardigan	+ 38	Brecon	+1277	Carmarthen	+1553
Flint	− 29	Cardigan	+ 378	Glamorgan	+1017
Radnor	− 75	Denbigh	+ 290	Carnarvon	+ 872
Denbigh	−316	Pembroke	+ 285	Anglesey	+ 833
Merioneth	−401	Flint	+ 239	Montgomery	+ 562
Pembroke	−521	Montgomery	+ 150	Merioneth	+ 297
Carnarvon	−542	Merioneth	+ 107	Pembroke	+ 239
Anglesey	−679	Radnor	+ 39	Brecon	+ 139
Montgomery	−712	Glamorgan	− 130	Radnor	+ 36
Glamorgan	−887	Anglesey	− 154	Denbigh	+ 26
Carmarthen	−907	Carnarvon	− 330	Flint	− 210
Brecon	−1416	Carmarthen	− 646	Cardigan	− 416
SCOTLAND.					
Clackmannan	+ 499	Caithness	+1903	Renfrew	+1276
Kircudbright	+ 244	Clackmannan	+1711	Inverness	+1138
Renfrew	+ 204	Edinburgh	+ 610	Lanark	+1047
Edinburgh	+ 185	Haddington	+ 535	Orkney	+ 878
Fife	+ 118	Bute	+ 533	Selkirk	+ 812
Berwick	+ 104	Wigton	+ 520	Dumbarton	+ 667
Argyll	+ 64	Ross	+ 473	Fife	+ 449
Dumfries	+ 22	Sutherland	+ 462	Sutherland	+ 257
Bute	− 35	Elgin	+ 430	Nairn	+ 230
Ross	− 40	Banff	+ 424	Perth	+ 196
Stirling	− 43	Ayr	+ 351	Berwick	+ 141
Dumbarton	− 89	Nairn	+ 326	Dumfries	+ 141
Forfar	− 98	Roxburgh	+ 297	Kincardine	+ 113
Linlithgow	− 105	Kirkcudbright	+ 275	Wigton	+ 32
Kinross	− 107	Aberdeen	+ 253	Roxburgh	+ 15
Ayr	− 175	Forfar	+ 243	Argyll	+ 11
Aberdeen	− 186	Linlithgow	+ 240	Peebles	− 11
Elgin	− 192	Kinross	+ 212	Aberdeen	− 67
Peebles	− 196	Peebles	+ 207	Stirling	− 73
Banff	− 232	Kincardine	+ 199	Caithness	− 101
Kincardine	− 312	Perth	+ 137	Haddington	− 102

Proportional change of 10,000 Families, chiefly employed

In Agriculture.		In Trade, Manufactures, or Handicraft.		Otherwise than the two preceding Classes.	
		SCOTLAND continued.			
Roxburgh . .	− 312	Stirling . . .	+ 116	Kinross . . .	− 105
Lanark . . .	− 319	Orkney . . .	+ 106	Linlithgow . .	− 135
Perth	− 333	Selkirk . . .	+ 95	Forfar . . .	− 145
Inverness . .	− 416	Argyll . . .	− 75	Ayr	− 176
Haddington . .	− 433	Dumfries . .	− 166	Banff	− 192
Wigton . . .	− 552	Berwick . . .	− 248	Elgin	− 238
Nairn	− 556	Fife	− 567	Ross	− 433
Sutherland . .	− 719	Dumbarton . .	− 578	Bute	− 498
Selkirk . . .	− 907	Inverness . .	− 722	Kirkcudbright .	− 519
Orkney . . .	− 981	Lanark . . .	− 728	Edinburgh . .	− 795
Caithness . .	−1802	Renfrew . .	−1480	Clackmannan .	−2210

To facilitate comparison, the total population of each county has been assumed at 10,000 families; and from this radix, the proportional number of families for each of the classes has been deduced by a simple numerical operation, from the absolute population recorded in the returns for 1811 and 1821. The *difference* between the results thus obtained for the two periods, in each county, produced the results given in the preceding tables; and which are so arranged, as to present, for one extreme, the maximum of increase, and for the other, the maximum of decrease; the intermediate steps indicating by their proper signs + or —, the increments or decrements of the respective counties, according as their respective divisions have been augmented or diminished. As an example, to prevent a misconception of the tables, it may be added, that during the ten years from 1811 to 1821, the agricultural population of Norfolk has *diminished* in the ratio of 125 families to 10,000; the county of Hereford has *increased* its manufacturing population in that of 58 families to 10,000; and Suffolk *decreased* the class of its non-productive labourers, 26 families out of the same number.

By a reference to the table of general results, it will be perceived, that the aggregate agricultural population of England, Wales, and Scotland, has diminished; but that the families employed in trade and manufactures have increased. The third, or unproductive class, has received a small diminution in England, but in Wales and Scotland they have been augmented, and in the former con-

siderably. Of the agricultural population it may also be observed, that Wales has undergone a greater diminution than either those of England or Scotland; and the classes of its unproductive labourers has likewise received the greatest augmentation. The feeble diminution also of the last-mentioned class for England, is worthy of particular remark; and from the manufacturing population having received an increase somewhat analogous to the depression of the class of agriculturists, it may be inferred, that during the ten years from 1811 to 1821, the class of artisans derived its increments from that of agriculture; the demand for labour having been more active in the former division than in the latter. The increments also, which the manufacturers of Wales and Scotland have received, may be properly attributed to the same source. The most important feature of the table of general results, and that indeed which deserves the most serious attention, is the great diminution of the agricultural population.

Of the individual counties it may be observed, that for agriculture, the maximum increase is in Rutland; for trade and manufactures in Stafford; and for the third, or unproductive class, in Durham. The latter county also presents the maximum decrement for agriculture; Northampton for manufactures; and Westmoreland for the unproductive class. The counties of Wilts and Leicester approach the nearest to the actual state of the aggregate agricultural population; and Gloucester, for the two succeeding classes. The county distinguished by the least change in its agricultural population is Southampton; and for the minimum change in its manufacturers, Bedford; and for its third, or unproductive class, Gloucester. The forty English counties, having each of the three classes divided into the general denominations of increments and decrements, are respectively, in point of numbers as follows:

Agriculture.		Trade, Manufactures, or Handicraft.		Otherwise than the two preceding Classes.	
	Counties		Counties		Counties
Increments . .	11	Increments . .	26	Increments . .	18
Decrements . .	29	Decrements . .	14	Decrements . .	22
Total . .	40	Total . .	40	Total . .	40

To give a more perfect idea of the great fluctuations which the three established divisions of the English population have undergone during the period under consideration, is the object of plate VII. The lines *ab*, *a'b'*, *a''b''*, may be regarded as lines passing through zero, or a common origin, and to which all the changes indicated in the preceding tables are referred. Those portions of the waving lines *above* those which denote the common origin of the changes, represent the counties distinguished by increments; and those *below*, the different decrements. The sums of the lines indicating the changes for each county, must obviously amount to the same constant quantity. The counties are arranged alphabetically, and not in the order in which they are recorded in the tables.

By contrasting the lines denoting the different changes with each other, it will be immediately seen how one is, in some measure, regulated by the other; how, for example, if a county as Cumberland, has *positive* changes in the second and third divisions of its population; how the class of agriculturists is immediately distinguished by a *negative* change, equal to the sum of the preceding; or how, if like Monmouth, the first and second classes are contrasted, and their variations are of an *opposite* kind, how the third class undergoes a change, equal to the *difference* of the two; partaking of a *positive* or *negative* character, according to the nature of the greater. The maximum increments and decrements are also clearly displayed in it; and likewise those counties in which the changes of their population have been the least.

In Wales it will be observed, that with the exception of Cardigan, the agricultural population of all the counties has diminished; and it is also remarkable, that the decrements in general are superior in magnitude to those of England. The numerical results also for the unproductive labourers in all the counties, excepting Flint, have signs precisely the reverse of those attached to the class of agriculture; proving that the former counties have gained accessions, partly, at least, from the latter. Cardigan having increased both its agricultural and manufacturing population, has diminished its unproductive members. Carmarthen, on the contrary, has

increased the latter class of persons from the other two classes, and most particularly from that of agriculture. The same remark applies also to Glamorgan, Anglesea, and Carnarvon. The last-mentioned county is also that which approximates the nearest, in the state of its agricultural population, to that of the aggregate population of the principality; the same being found to be the case in Radnor, for trade and manufactures; and in Montgomery, for that of the unproductive labourers.

Of the thirty-two counties composing Scotland, it may be remarked, that eight are distinguished by an increase of their agricultural population, and twenty-four by a diminution thereof; but of the population devoted to trade and manufactures, twenty-four counties have received increments, and the remaining eight decrements. Sixteen also of the counties have received an augmentation to their non-productive members, and the remaining number a diminution.

The magnitudes of the numbers indicating the extreme changes may considered as remarkable, when contrasted with the corresponding results for England. Caithness, for example, is distinguished by an increment to its manufacturing population of + 1903, and by a decrement to its agricultural members of − 1802. Renfrew has also increased its non-productive members by + 1276, and Clackmannan diminished the same class by − 2210. The county distinguished by the least change in its agricultural population is Dumfries; Selkirk in its families devoted to trade and manufactures, and Peebles in the class of its non-productive members. The families devoted to agriculture in Peebles, approach also the nearest to the change of the aggregate population of the first class; Selkirk also in its trading and manufacturing, and Perth in its non-productive, members, to the respective changes in the aggregate members of the corresponding classes. Caithness presents also an example of a remarkable decrement in its agricultural population, and of a more considerable increase in its manufacturing members; but only a very moderate decrement in its negative members. Clackmannan likewise has very rapidly diminished the latter class, increased in a very great degree its

manufacturers, and received a small increase in its agricu population. Inverness presents also an instance of considerable declensions in its agricultural and manufacturing members; and an increment equal to both the preceding decrements, to its unproductive families. A similar remark applies also to Dumbarton and Lanark. The declension of the manufacturing families in Renfrew, and their probable change into the unproductive class, likewise merits attention.

By an inspection of this part of the table, it appears that the aggregate of the *increments* for agriculture, amounts to 1437; whereas that of trade and manufactures is 10,658, the *latter* exceeding the *former* in a greater ratio than that of 7 to 1. The aggregate of the *decrements* of agriculture amounts also to 9,143, and that of trade only to 4,564; the former exceeding the latter in the ratio of 2 to 1.

Art. III. *On the Herring. By* J. Mac Culloch, M.D., F.R.S.

The natural history of the animals useful to man, is not merely an amusing pursuit, but forms one of the most valuable branches of this department of knowledge. Yet it has been the blame of naturalists to have too much neglected this branch of their science, in their attention to classification and nomenclature. If there are not many of the wild or still undomesticated animals from a knowledge of whose habits we might derive advantage, there are still some that are loudly calling for this kind of investigation. From the state of ignorance that we are still in respecting these, we are not only forfeiting advantages which we might secure, but are also subject to serious losses and frequent disappointments.

This is peculiarly true of the herring. The following remarks will show, not only what advantages we might derive from an accurate acquaintance with the natural history of this fish, or with what may be called its moral and political history, but demonstrate the heavy losses in a commercial view, which have been the consequence, not merely of this ignorance, but of false theories on

that subject. If it is difficult to acquire this knowledge, we must recollect that nothing remains long impossible to industry and observation. That nothing rational has been yet attempted, is equally a stimulus and an encouragement; nor do I know of any department of this branch of natural science, whence an industrious naturalist might derive more honour, with the additional satisfaction of having conferred solid and important benefits on mankind.

The respect due to Pennant's name, will not permit us to speak lightly of him; yet, on this subject, he seems to have either given way to the influence of his imagination, or to have copied without inquiry from the works of others, what deserves nothing but the name of a pure romance. The readers of his work on *Zoology* must be aware of the theory to which I have given this name. Yet I am uncertain if it originated with himself, or with Anderson the historian of Greenland and Iceland. Since it is necessary however that it should be stated, as the foundation of this brief sketch, I shall give the most condensed view of it that I can, from he latter author. It is marvellous that such a tale should have been copied and quoted, and reprinted, not merely by the herd, but by the careful authors of the French Encyclopædia; and that, thus transmitted, it should not only have been believed for half a century or more, by those who, if they had reflected for an instant, or even opened their eyes, must have seen that it was a fable, but that it should have been the foundation of numerous expensive commercial establishments, standing to this day as testimonials of the fiction of one party, and the credulity of others.

Anderson commences by saying that, in Iceland, the herrings are two feet in length; which is a preliminary worthy of what is to follow. Every summer, he proceeds to say, an army of these fish leaves those northern regions, being chased southwards by whales, grampuses, sharks, and other large predatory fishes. As this army proceeds to the south, it divides into two columns; the eastern one making for the North Cape, and descending along the coast of Norway. This eastern wing, however, divides itself again into two other columns; one of these entering through the Sound into the Baltic, and the other proceeding for the point of Jutland.

This latter again splits on that point into two lines, one of which defiles along the eastern shore of Denmark, and then entering the Belts, reunites itself to the Baltic division; while the other, coasting Heswick, Holstein, Bremen, and Friesland, enters by the Texel into the Zuyder Zee, so as again to return into the north sea.

The second grand division of the original army, which had taken to the westward, is, according to this naturalist, the largest of the two. It proceeds straight for Shetland and Orkney, and thence goes on to Scotland. Here it divides, like the former eastern column into two divisions, or subsidiary columns, one of which proceeds down the eastern coasts so as make the round of England by the British channel, while at the same time it detaches parties into the harbours of Friesland, Holland, Zealand, Brabant, Flanders, and France. The western division, during this time, separates itself again in such a manner as to visit the coasts of Ireland and the western lochs of the Highlands, producing the Irish and Highland fisheries; visiting also the Isle of Man, where the herring fishery is notedly abundant. In its further progress, this Irish and Highland army reaches the land's end, and here finally reunites itself to the eastern one whence it had separated, meeting it at the entrance of the channel. Thus reunited, the great original western division of the entire northern army, makes a rendezvous in the Atlantic, where, it must be supposed, they take an account of the killed and missing, before they return again to Iceland and the Polar seas, to renew the same march in the following summer.

It is sufficient to read this account to perceive, even without evidence to the contrary, or an examination of the subject, that it must be a pure romance. It is plain, *à priori*, that there are no means of ascertaining such a series of facts, nor even of approximating to a much less detailed history than that which is here given; even admitting that the basis of the extravagant superstructure were true. The few facts that I have to offer, will demonstrate that it is an entire vision. That the herring is, to a certain degree, a migratory fish, may be true; but even a much more limited migration than this is far from demonstrable. It is at any rate perfectly certain that it does not breed exclusively in the

Arctic seas, and that it does not, as the author and Mr. Pennant imagine, migrate " heaven directed" to our shores. It is equally certain that it does not take the directions here described along them, that there is no such progress along the east and west coasts from a central point, and no such reunion at the Land's end. It is no less certain that its appearance, instead of being thus regular and constant, is quite the reverse, and that it is marked by extreme irregularity, as well for the period, as for the places visited. Of the imaginary original eastern army, I do not pretend to know much: the few remarks I have to offer, refer principally to the western or supposed Scottish column.

With respect, in the first place, to the original breeding station of the herring, the statement is unsupported by any evidence. We have no actual reports respecting their breeding or abundance in the northern seas. I cannot find that they have been remarked as abounding in the Arctic ocean, nor that they have been observed in the proper icy seas. They have never formed a fishery either in Greenland or Iceland: nor have our whale fishers taken any particular notice of them. It is a pure error to suppose that the great northern whale feeds on them. That fish is incapable, from the structure of its œsophagus and mouth, of swallowing so large a fish; and its food is well known to consist of minute shrimps, beroes, clios, and other marine worms and insects, among which the cancer pedatus and oculatus appear to be the most remarkable. The whale which pursues the herring on the Scottish coasts, is the piked, or bottle-nosed whale; an animal of very different anatomy and habits.

On the subject of the imaginary eastern army, all that appears to have been ascertained relates to the Swedish and Norwegian fisheries. The herrings were first noticed on the coasts of Sweden in 1740, and at that period the Gotheburgh fishery was established. The herrings were also abundant on the coasts of Norway before 1790. After that date they deserted those, and made their appearance at Marstrand. So far also from this visit having been among the first, which it should have been according to Anderson's state-

ment, they did not appear till November, when the Swedish fishery commenced. The produce also was so abundant, that in the short space of three weeks it amounted to 600,000 barrels. Since that period, however, they have deserted this coast.

This statement is sufficient to show the fallacy of the imaginary visit and progress of the eastern division of the equally imaginary Arctic herrings; and I may now inquire respecting the supposed western one that appears on our own shores.

Now, so far are they from being migratory to us from the north, that there can be no doubt of their breeding on our own coasts. Yet the period of breeding, no less than the time of their visits, seems as irregular as every thing else that belongs to this apparently most capricious fish. That they do breed with us, is proved by their spawn being taken on many of the coasts where the full grown fish is found: and if that has not been found on all, it probably depends, partly on want of observation, and partly on the regulation for the minimum size of the herring nets. In Orkney, in 1699, an immense quantity of herring spawn was thrown on shore during some tempestuous weather; proving that they then bred there. Yet, for a long period, they have entirely deserted the coasts of Orkney and Shetland: and it is only within three or four years that the Orkney fishery has recommenced. This circumstance marks a change of haunt and of spawning-places, but not a migration of the full-grown fish; and is plainly inconsistent with any progress from the northward. Had they migrated in the manner stated, they must necessarily have appeared in Shetland and Orkney every year, while they would also have appeared there first, instead of being, as is the fact, utterly unknown about the former islands.

It is difficult, or rather impossible, to account for their thus changing the places of their spawning, not only in these islands, but upon the British coasts in general; but these very changes of haunt prove also that they have no more any fixed rules for it than they have fixed migrations. Whether they did always spawn in these places where they were formerly abundant, cannot

now be ascertained. But it is probable; partly from the fact just related of Orkney, and partly because, before the mesh regulation, they used to be taken of all sizes by the country fishermen.

Of these changes of place, the few following will be sufficient example and proofs. In the time of Charles I., and long afterwards, the Long island was their great resort; and at Loch Maddy alone in North Uist, 400 sail of vessels have been loaded in one season. These last events were about the beginning of the last century. At the prior period which I mentioned, buildings were erected in this inlet, and a regular fishery established; but they have long since deserted, not only this spot, but all the shores of the Long island. It is scarcely now even remembered by the people when they last appeared in any quantity.

From the beginning of the last century, for a considerable period onwards, their chief resort was about Loch Ewe, Loch Torridon, and, generally speaking, to the northern lochs of the west coast. About the same period they were then also abundant on the coasts of Sky. This state of things is well remembered, and it lasted for a long time. It is well remembered because it was the cause of much writing; finding its way into such popular works as Goldsmith's light essays, and producing as many pamphlets and as much talk as politics have done at other periods. The poet Aaron Hill, was then entrusted with the direction of one of these fisheries, and if I mistake not, one of Mrs. Charlotte Smith's novels was written in Sky, from a similar connexion on the part of her husband. It is even better remembered by those who sank large sums in this vast speculation. Hence were erected the enormous establishments at Loch Torridon, at Martins' island, and on Tanera, now long become useless; and the anticipations founded on it equally led to the establishment of Steen and Tobermory, and of other towns which have long ceased to make any progress, partly from the desertion of the herring shoals, and partly from the wrong principles on which the Fishery Society proceeded. I may here also remark, that in 1700, when they were abundant in Sky, it was ascertained that they bred there.

These are the losses to which I alluded at the commencement of this paper, which were caused by false views of the proceedings of the herrings. I do not know how far these establishments originated in the Arctic Theory, because some of them are prior, at least to the publication of Pennant's opinions: but it is very certain that many of the more recent ones proceeded on this foundation, believing that the migration of the herring was steady and certain. Nothing else could have led to the sinking of so much capital; the nearly total loss of which has been the result of this false information, or theory, and inconsiderate expenditure.

To pursue this part of the subject; at a later period, they seem to have preferred the lochs further to the south. Thus Loch Hourn and Loch Nevish became the great fishing stations, as did the Sound of Sky. But, warned by their preceding failures, no buildings were erected in these, and the fishery was managed by means of boats and busses in the present method. Thus also they made Loch Fyne one of their principal resorts, moving in a great measure towards the Clyde, or further south; though it also happened that they were abundant in these lochs, and also in the neighbourhood of Sky at the same period. Thus Portree, Scalpa, Loch Hourn, Loch Ransa, and Loch Fyne, have, within a few years, been the great resorts; yet very irregularly: and in this manner has Campbell town, which depends chiefly on the herring fishery, fluctuated between wealth and bankruptcy. For a single season, not many years ago, Loch Scavig in Sky was crowded with them in a manner perfectly incredible. Yet, before and since that period, they have been unknown there; marking in a very pointed manner, the extreme irregularity and caprice of their movements. All these seem mere changes of haunt, unconnected with any particular migration, and for which no causes can at present be assigned.

Vulgar philosophy is never satisfied unless it can find a solution for every thing; and is satisfied, for this reason, with imaginary ones. Thus, in the Long island, it was asserted that the fish had been driven away by the manufactory of kelp; some imaginary coincidence having been found between their disappearance and

the establishment of that business. But the kelp fires did not drive them away from other shores, which they frequent and abandon indifferently without regard to this work. It has been a still more favourite and popular fancy, that they were driven away by the firing of guns; and hence this is not allowed during the fishing season. But this, like the former, is *causa pro con causa.* A gun has scarcely been fired in the Western islands, or on the west coast since the days of Cromwell; yet they have changed their places many times in that interval. In a similar manner, and with similar truth, it was said that they had been driven from the Baltic by the battle of Copenhagen. It is amusing to see how old theories are revived. This is a very ancient Highland hypothesis, with the necessary modification. Before the days of guns and gunpowder, the Highlanders held that they quitted coasts where blood had been shed: and thus ancient philosophy is renovated. The steam-boats are now supposed to be the culprits; since a reason must be found. To prove their effect, Loch Fyne, visited by a daily steam-boat, is now their favourite haunt; and they have left Loch Hourn and Loch Torridon, where these have never yet smoked.

The recent and present state of the eastward fishery will furnish facts equally at variance with any theory of the herring; and as it is only by collecting and comparing these that we can form any hopes of attaining a true one, I may state the more important particulars.

In former times, the fishery of the east coast did not commence till that on the west had terminated It was then supposed, and not very unreasonably, that the fish had changed their ground, and that these were the western herrings. Yet it ought to have been plain that this was not the case, as the eastern fish were entirely different in quality from the western, and very far inferior. At the same time, they were in that condition as to spawning, which proved that they could not have been the same fish. The fact of their being entirely different fish is now at least fully proved, because on both shores the period of the fishery has been the same. It is remarkable also that the eastern fishery has become so abun-

dant, as quite to have obscured the western ; while the quality of the fish has also improved, although they continue to be still far inferior. In 1820, this eastern fishery was so abundant as to have overstocked the whole market, foreign and domestic; procuring considerable loss to the merchants, and materially checking its future progress. It is further to be remarked in this case, that so far from there being any indications of a progress from the north, the fishery has commenced soonest on the southern parts of this shore; and, what is also remarkable, that for some years since that, it has become later every year. Of its actual state I cannot speak precisely, because my observations terminated with 1821.

I might extend the same kind of remarks to the English fisheries, but it is unnecessary. That of Yarmouth, and that of the Isle of Man, are among the most steady. A few years ago, they were taken in such abundance for the London market on the coasts of Kent and Sussex, that they could not be consumed, and were employed as manure; and other changes equally unintelligible have occurred on the eastern and southern coasts of England, as well as the north shore of Cornwall.

That this capricious conduct is not peculiar to the herring, is proved by the recent state of the Pilchard fishery of Cornwall, and by the changes which the Sardinian fishery of Britany has undergone. The almost entire desertion of this fish from the former country, where it had been annual and abundant to a proverb, forming a steady and valuable object of commerce, is as yet unaccounted for. Lately, it has shewn symptoms of again returning.

It seems at any rate perfectly ascertained with respect to the herring, that it breeds on our own shores; and this is the important point which the preceding remarks serve to ascertain, though they yet leave the changes of place unaccounted for. It seems to reside permanently in the deep surrounding seas, and apparently round the whole island, though more abundantly to the northward. This is clearly proved by the Dutch fishery, which was carried on at all times in the deep sea, and constituted that very fishery which was supposed to have produced to Holland such enormous wealth, and which excited our jealousy, and stimulated

our attempts. This was well known in Pennant's time, and long before, since it is a fishery of a very ancient date; and it ought to have prevented the promulgation of the absurd theory which I have here contested. It is now equally known to ourselves, from our own deep sea fishery; though that is comparatively little pursued, for reasons which will appear hereafter.

The approach to the shores is performed, in the first place, for the purpose of spawning, as this operation can only be carried on in shallow waters; and hence the resort of the fish to the lochs and bays. It is probable also that the pursuit of food is another reason or motive; and, among that food, we may reckon the medusæ and other analogous marine vermes, which are produced in such abundance during the summer, in all these shallow seas. Nor is it unlikely that the herrings are driven in to the coasts by their enemies, the piked whale, the grampus, and the fin-fish, as well as by the cod and other smaller fishes that make prey of them.

If all these motives variously combined will not account for their irregularity, they may at least aid in doing so. Hence, its haunts, as well as its periods may vary. That the season of spawning in different fish takes place at different periods, is apparent from the different states as to fulness in which these are taken at the same time. Hence the periods of their approach to the shores must vary, and hence also the full growth of the young fish must be established at different periods. As to the food, the season and place in which that is produced is known to vary, as does its abundance; and this, unquestionably, must be one of the powerful motives by which their appearance both as to time and place is regulated. The appearance of their great enemies is no less uncertain, and thus also we approximate somewhat nearer to the causes of all these variations. Since there is reason to believe that the herrings feed on the medusæ, and as the presence of these is known by the luminous state of the water, it is very likely that this might, in itself, form some guide to the fishermen for their presence. But as they have not hitherto been aware of the cause of the luminous state of the water, this indication has been neg-

lected. In many seasons, the waters of particular bays are highly luminous, and crowded with these animals; while, in others, they are utterly wanting. We might expect that the presence of the herrings would vary accordingly; but though I have thus observed it, the observations have not been sufficiently repeated to allow of establishing a general rule.

I have already remarked that the season of spawning is apparently uncertain and various, and this seems confirmed by the discordant opinions of the fishermen on this subject. It seems, at any rate, to be fully ascertained, that they spawn in the same lochs where they are taken. The herring spawn abounds in these places in the season of the fishery; and, with small nets, fish of all sizes are taken. The spawn is also then devoured by cod, coal fish, and others which follow them; as they are in great abundance by the sea birds, particularly by the smaller gulls and the terns, which may be constantly seen flocking above the shoals, as the shoals of coal-fish are also found following them. Thus also they are found round the shores of the Isle of Man; and hence it appears that the proper season of the herring fishery in the lochs, is that in which they arrive for the purpose of spawning; and hence the condition in which they are taken. The young also seem to haunt the seas and bays where they have been produced, till they are full grown; but they are now seldom taken under the full size, on account of the strictness with which the law for destroying the small meshed nets has been enforced. The fish which has spawned returns to the deep sea to recruit itself; and thus the shotten herring, as it is called, is seldom taken.

It is further evident that the season of spawning must vary on different shores, because, at the same time, the fish is taken in different conditions on different shores, or is found at far distant times in the same condition. This happens comparatively on the east and west coasts of Scotland; as it does in comparing the west coast, or the Isle of Man, with the eastern coast of England. It would be very important for the fisheries to ascertain the exact season of spawning for each place, on account of the great difference in the goodness of the fish according to the condition in

which it is taken. Independent of this, the herring is always in a much higher state of feeding on the west than the east coast, and is also much superior in size, flavour, and quality. In point of flavour, indeed, it is scarcely the same fish; being as much superior as a salmon is to the worst sea trout. This difference, in itself, would be enough to prove that no migration took place from the west to the east coast. I may add to the confusion which belongs to this subject, what I do not pretend to solve; namely, the various conditions as to fulness in which the herring is taken in the same place and at the same time. We might perhaps conclude from this, as from the other facts stated, that the season of spawning is very uncertain, and that, in this case, different tribes of fishes, or different fish, had been intermixed.

It appears to be a further proof against any migration of herrings in a body, even from the deep seas to the shores, that when they first arrive, and for the apparent purpose of spawning, they are not in shoals. They cannot then be taken by nets, from their dispersion. But the Highlanders then fish for them with a feather or a fly, and a rod, and, by this very amusing fishery, they take them in sufficient quantity to render it a profitable occupation; as one man has been thus known to take a barrel and a half, or about 1200 fish, during the few days this fishery lasts. It is thought that they again disperse after spawning before they collect into shoals, so as to give cause for a second fishery of the same nature.

Such are the principal facts which I have been able to collect, respecting the natural history of the herring, and the physical history of the fishery on the coasts of Scotland. Having had but slender opportunities of observation or inquiry, no other apology is needed for not having done more. I believe there is much more knowledge dispersed among the fishermen, for him who might have opportunity and dexterity to extract it. The people observe; but having neither system, nor interest to record, their knowledge is forgotten or neglected, even by themselves. He who should bestow his attention on this subject, for a few summers, might probably attain a knowledge of the most important facts yet remaining, and complete what I have only sketched.

It is the duty of the Board of Fisheries to add this to their other exertions; and if that has not yet been done, it is perhaps because it has been thought sufficiently known, or, possibly, because it is supposed unattainable. It cannot be supposed unimportant; and that it is neither of all these three, I hope I have proved. At least I have justified the criticism with which I commenced on the theory of Anderson and Pennant. It will not be uninteresting to add a few words on the present commercial and political state of the Herring Fishery.

That fishery, so long a subject of anxiety and speculation and regulation, has now arrived at a state more extended than was so long wished for, and so long despaired of. It has occasionally exceeded the demand; and in 1820, it considerably and injuriously overstocked the entire market. It must be known, at least to those who have attended to the history of our commerce, that our anxiety about this branch of trade was excited by our jealousy of our neighbours the Dutch, who were represented as raising gold from the mines of the ocean, and as infringing on our rights and property; insulting our indolence at the same time by their superior industry. I may refer to the pamphlets and newspapers, almost to the romances and poetry of the day, for the public opinion on this subject.

That this subject gave rise to as much nonsense as ever was written, need scarcely be told; while the greater the difficulty which we imagined we found in coping with them in this field, the greater was our anger. These politicians forgot that Holland was overflowing with capital and industry, and was driven to this occupation for want of other employment for its people, as of vent for its capital. They forgot also that the industry and capital of Great Britain were much more profitably, as well as more agreeably, occupied; and that neither force, nor bad writing, nor bounties, nor acts of parliament, would succeed in diverting either from a profitable trade to a bad one, or from occupations of little labour to one extremely laborious and disagreeable. Yet thus were passed the chief Acts of Parliament in Charles the Second's time, particularly after 1672; when it is palpable that they were

also as much dictated by a spirit of jealousy, as the desire of gain.

Pursuing the same system, the bounties were established in 1748, and as the quantity or rate of these fluctuated, the herring fishery rose and again declined. It was at a low ebb during the American war, as well as during the last.* Nor could any reasonable bounty have enticed capital into it under those states of commerce; though our politicians did not even then appear to have reflected that there was no capital to spare for such an employment, that there were abundant and much more enticing demands on it from other quarters, and that the trade itself had the further demerit of being new, precarious, and disagreeable. This was the true cause of the declension of the herring fishery; and were the same causes to be renewed, it would decline again. If it is now flourishing, it is chiefly from the superabundance of capital, and from the want of better outlets to our industry. England will have cause to lament the day which shall render her the great herring fisher; the rival of the ancient Dutch, and the envy of politicians of the same caliber as Aaron Hill and Oliver Goldsmith.

The raising of the barrel bounty to four shillings in 1815, and the admission of rock salt in 1817, were the last regulations, and those under which this trade is now flourishing. These are all, at least that I shall notice, as I cannot here afford to trace the whole history of the fishing regulations, since they would in themselves make a volume. The chief of the others, however, which do require notice, was the Act for the minimum of the meshes, (a very questionable policy as it regards the domestic fishery,) and the method of gutting and bleeding the fish, as practised by the Dutch. Under this process, where carefully followed, the Scottish herrings are now found to be equal to the Dutch, and to compete with them in the foreign market. The bounty regulation is a very doubtful benefit. It is costly without being necessary; and amongst the fishermen in general, the restrictions and trouble which attend the various regulations, are so great as to make it a very common wish that it should be rescinded, and the whole trade left free. It is argued, on the other hand, that, without force, the fishermen and

merchants will make and sell bad fish; to which the obvious answer is this, this would be against their interests, as they would soon have no buyers.

But to pass from this. There has been, under these various circumstances, a progressive increase in the quantity taken; while from 1816 to 1820, beyond which this sketch does not extend, the quantity cured according to the regulations, and therefore entitled to the full bounty, has also progressively increased. But there is another important cause here implicated. The great increase has not arisen from the extension of the Buss, or deep sea fishery, but from that of the boat fishery. This is carried on by the small farmers and fishermen who reside on the sea-shores, who sell to the busses, which thus find it a more profitable trade to buy from them than to fish for themselves. Thus far our fishery differs from that of the Dutch, which was carried on by large sloops or herring busses in the deep sea. Thus the main cause of the increase is not to be sought in the acts of parliament and regulations only, nor exclusively in the superabundance of capital. It has been one chief result of the alterations in the system of Highland farming, by which, in consequence of the allotment of the interior tracts to sheep, the people have migrated to the sea-shores as occupiers of fishing crofts. While this mode of fishing has been found the most profitable, in a commercial view, it has also produced the advantage of finding employment for the formerly unoccupied people of the Highlands, and has been, in fact, one of the great but overlooked benefits, which has flowed from a system against which such a senseless and protracted clamour has been raised.

It is, perhaps, time to reflect whether bounties can any longer be necessary. The solution of this question must be sought in the preceding facts. Circumstances have changed. Capital is now seeking employment. So is Highland industry; so is industry in general. If the bounties force a larger fishery than finds a vent, they are no longer beneficial; they cannot at least be necessary. But I need not dwell on this part of the present subject. I shall, therefore, pass over all that relates to the present legislative regulations, whether as these relate to salt, or to any thing else, for the

purpose of offering a few remarks on the singular state of the market.

If we take the year 1820 as a standard, the herring fishery has not only arrived at its maximum, but has exceeded that, and must be reduced. It has, once at least, exceeded the demand, as I shall presently show. Now as the supply appears inexhaustible, and as the demand for food appears equally so, it is an object of curiosity to inquire what it is which has thus brought it to a state of rest; a state of rest which would at least seem to render all further encouragement unnecessary. This is true of other fisheries. The Ling fishery of Shetland is in the same state, restricted by an insufficient demand. If it is inquired why they do not fish more, the fishermen answer briefly, " the people will eat no more salt fish." Thus they account for that limited demand which checks their industry, and which also, as in all similar cases of limited and doubtful demand, generally keeps the supply down to a state somewhat lower than that which would really find a sale. This must be recollected, in examining this question; for however a greater or an occasionally higher sale might occur, it is the business of the producer, for his own interest, first to take care that there is really a demand, and then to watch that his supply shall not exceed it. It is the object of the merchant to see that demand both precedes and exceeds supply.

It appears very difficult, practically, to admit the theory of the fishermen as it relates to the consumption of salt fish. As to the West India demand for herrings, that can be accurately calculated, because it is compulsory on the consumers. The Spanish demand for ling is equally certain and regular; because it is also compulsory from other causes, and because there is no great fluctuation in the number of consumers. In neither case is it a matter of taste or opinion, and it is therefore subject to no caprices. But that the people of Britain who are often in want of animal food, those of Ireland and Scotland in particular scarcely ever seeing it, should refuse to eat salt fish, is hardly credible. They assuredly show no dislike to it on the sea-coasts where they have ready access to it; and in most maritime districts indeed, it forms a princi-

pal part of their diet. It is not to be supposed that the labourer of the interior would not eat herrings rather than be confined all the year to oatmeal, potatoes, or bread; and if there is no fish consumed in these districts, it must be from want of knowledge, want of habit, or from defect of the internal commercial arrangements of the county.

That it would be highly advantageous, both to the people themselves and to the merchants and fishermen, to diffuse that habit and that knowledge, can admit of no doubt; as it is folly to say that salt fish is not a nutritious diet. That this has been neglected, is equally apparent; and it seems particularly to have been neglected by our monstrous charitable establishments, in whose department it would seem particularly to lie. If it were possible to excite such a demand, and that a steady one, our fisheries would prosper in proportion, and can now prosper in no other way, as they have overstocked the foreign market; that market which cannot be extended as the home one may. But as long as the fishermen are checked by their frequent losses on a perishable commodity of precarious sale, they must restrict or withdraw. To excite such a fashion or demand, would be an act worth all bounties that ever were invented. The true object of policy is not to produce the article, but to produce a sale for it.

If we reflect on our peculiarly maritime situation, the inexhaustible supply which our seas afford, and the constant occupation for industry here found, it has been a singularly unfortunate circumstance, that those who framed the model of our Reformed Church did not retain at least the weekly fast. It is a misfortune that they had not been persons of more general views, and economists. Much was retained that was matter of indifference on the great points at issue; for the sole purpose of drawing a line short of the extremity of reform. Had this also been retained, a point in itself indifferent, the beneficial consequences would have been very great; as it would not only have operated by its direct effects, but have tended to diffuse the general commerce of fish in the interior of our own country, and the general habit of consuming it. It is easy to conjecture how advantageously it would have

operated, when, even now, we derive so much benefit from the fasts of the foreign Catholic church as the ground of a branch of commerce.

But I must conclude this sketch of a subject which might easily be extended to an inconvenient length, and shall subjoin some documents from the official reports, as proofs and illustrations of some of the preceding views and arguments. They will shew among other things, the state of the market and the supply, and the comparative produce of the east and west coasts of Scotland. The period I have selected is one of five years, as I cannot, without trespassing on the prescribed bounds, take a larger one.

In 1815, there were about 160,000 barrels cured; and in 1816, this had increased to 163,000 only. In 1817, the increase was to 192,000; and in 1818, it took a sudden start, and was 228,000. In 1819, it had advanced to 326,000 on the east coast, and we here trace distinctly its gradual increase and parallel course, to the various causes I have already laid down. The increase in 1820 had advanced, even on 1819; but though I have lost this document, the consequences were such as to have left a considerable quantity on hand unsaleable, producing a very serious loss to the merchants.

As to the east and west coasts, in 1819, the proportion was about 81,600 for the latter, that of the former being, as already stated, 326,000; but as the boats of Glasgow, Grenock, and Rothsay, stand for about 53,000 of the latter, and as they buy on the east as well as the west coasts, it is estimated that the eastern was to the western fishery as 280 to 45 nearly. Formerly, the eastern fishery was limited to Wick, which also furnished 21,000 of the produce of 1819. The remainder is, in a great measure, to be attributed to the improvements upon the Sutherland estate.

I must now remark, that the average weight of the herring cask is between 120 and 130 pounds, and that the number of fish averages 800. Now the exportation of white herrings in 1819, was about 227,000 barrels; leaving about 108,500, or eighty-seven millions of fish, for home consumption, exclusive of the comparatively small quantity produced by England and the Isle of

Man. If we take the nearest round numbers, and allow only two herrings a day for an adult, this would be an annual supply of a proportion of animal food for little more than 119,000 individuals. But this quantity would scarcely be a sufficient supply of food for 40,000 persons, allowing six fish a day. It is hardly necessary to remark how trifling a supply this is for the home consumption, in an article of which the production seems to be illimitable. It is plain that much may yet be done towards increasing the food of the people, when the habit shall have been excited, and the circulation of this article better understood. The price is not the obstacle, because the price of 800 fish was only twenty shillings. Animal food could not well be cheaper than when nearly two herrings could be procured for a halfpenny, or when an adult could be completely fed for three halfpence a day. That, with such a price and such possibilities, the poor of this country should have wanted animal food in 1819, when the market was glutted to the ruin of the proprietors, is not one of the least curious facts in a science which has for some time abounded, even to weariness, in theoretical writers.

J. Mac Culloch.

Art. IV. *A new Demonstration of* Taylor's Theorem. *By* Edward Wilmot, Esq., T.C.D.

[To the Editor of the Quarterly Journal.]

Sir, *September* 16, 1823.

Those who are in the habit of lecturing in the elementary parts of mathematics, must frequently feel the difficulty of making the common proofs of *Taylor's Theorem* for the development of functions intelligible to the junior students. This difficulty I have myself frequently felt, and I know it is complained of by the professors in the French colleges. I am, therefore, induced to send you a demonstration which appears to me at once simple and valid. It is independent of those assumptions in functional principles which are involved in the proofs, and which, though they are perfectly clear to the expert and practised analyst, are always embarrassing, and often absolutely unintelligible, to the beginner. The proof which

I annex was given me at one of my lectures in our University by an undergraduate, whose knowledge of the calculus was limited to the first twenty sections of Lacroix. It is independent of the theorem of Maclaurin, and gives that series as a particular case. In this respect, amongst others, it excels the proofs of Lacroix.

I am Sir, &c.

DIONYSIUS LARDNER, A.M.
University of Dublin.

Demonstration of Taylor's Theorem, by Edward Wilmot, Esq. *Trinity College, Dublin.*

Let $n = F(x)$ and $n' = F(x+h)$; let

$$n' = A + B(x+h) + C(x+h)^2 + D(x+h)^3 + E(x+h)^4 \ldots\ldots$$

Where A, B, C, ... are independent of x and h. The powers of $(x+h)$ being expanded, and the series disposed by the dimensions of h, it becomes

$$n' = (A + Bx + Cx^2 \ldots) + (B + 2Cx + 3Dx^2 \ldots)\,h + (C + 3Dx + 6Ex^2 \ldots)\,h^2 \ldots\ldots$$

The successive co-efficients of this series are evidently

$$n, \frac{dn}{dx}, \frac{d^2n}{dx^2}, \frac{1}{1.2}, \frac{d^3n}{dx^3}\cdot\frac{1}{1.2.3}, \frac{d^4n}{dx^4}\cdot\frac{1}{1.2.3.4}, \ldots$$

Hence we have

$$n' = n + \frac{dn}{dx}\cdot\frac{h}{1} + \frac{d^2n}{dx^2}\cdot\frac{h^2}{1.2} + \frac{d^3n}{dx^3}\cdot\frac{h^3}{1.2.3} + \ldots$$

By supposing $x = o$ in this series, we find that of Maclaurin.

ART. V. *Historical Statement respecting the Liquefaction of Gases. By* Mr. M. Faraday, *Cor. Mem. R. Acad. Paris, Chem. Assist. in the Royal Institution,* &c.

I WAS not aware at the time when I first observed the liquefaction of chlorine gas*, nor until very lately, that any of the class of bodies called *gases*, had been reduced into the fluid form; but, having during the last few weeks sought for instances where such results might have been afforded without the knowledge of the

* *Phil. Transactions,* 1823, pp. 160.189.

experimenter, I was surprised to find several recorded cases. I have thought it right therefore to bring these cases together, and only justice to endeavour to secure for them a more general attention, than they appear as yet to have gained. I shall notice in chronological order, the fruitless, as well as the successful, attempts, and those which probably occurred without being observed, as well as those which were remarked and described as such.

Carbonic Acid, &c.—The *Philosophical Transactions* for 1797, contain, p. 222, an account of experiments made by Count Rumford, to determine the force of fired gunpowder. Dissatisfied both with the deductions drawn, and the means used previously, that philosopher proceeded to fire gunpowder in cylinders of a known diameter and capacity, and closed by a valve loaded with a weight that could be varied at pleasure. By making the vessel strong enough and the weight sufficiently heavy, he succeeded in confining the products within the space previously occupied by the powder. The Count's object induced him to vary the quantity of gunpowder in different experiments, and to estimate the force exerted only at the moment of ignition, when it was at its maximum. This force which he found to be prodigious, he attributes to aqueous vapour intensely heated, and makes no reference to the force of the gaseous bodies evolved. Without considering the phenomena which it is the Count's object to investigate, it may be remarked, that in many of the experiments made by him, some of the gases, and especially carbonic acid gas, were probably reduced to the liquid state. The Count says,

"When the force of the generated elastic vapour was sufficient to raise the weight, the explosion was attended by a very sharp and surprisingly loud report; but when the weight was not raised, as also when it was only a little moved, but not sufficiently to permit the leather stopper to be driven quite out of the bore, and the elastic fluid to make its escape, the report was scarcely audible at the distance of a few paces, and did not at all resemble the report which commonly attends the explosion of gunpowder. It was more like the noise which attends the breaking of a small

glass tube, than any thing else to which it could be compared. In many of the experiments, in which the elastic vapour was confined, this feeble report attending the explosion of the powder, was immediately followed by another noise totally different from it, which appeared to be occasioned by the falling back of the weight upon the end of the barrel, after it had been a little raised, but not sufficiently to permit the leather stopper to be driven quite out of the bore. In some of these experiments a very small part only of the generated elastic fluid made its escape, in these cases the report was of a peculiar kind, and though perfectly audible at some considerable distance, yet not at all resembling the report of a musket. It was rather a very strong sudden hissing, than a clear distinct and sharp report."

In another place it is said, "What was very remarkable in all these experiments, in which the generated elastic vapour was completely confined, was the small degree of expansive force which this vapour appeared to possess, after it had been suffered to remain a few minutes, or even only a few seconds, confined in the barrel; for upon raising the weight, by means of its lever, and suffering this vapour to escape, instead of escaping with a loud report it rushed out with a hissing noise, hardly so loud or so sharp as the report of a common air-gun, and its effects against the leather stopper, by which it assisted in raising the weight, were so very feeble as not to be sensible." This the Count attributes to the formation of a hard mass, like a stone, within the cylinder, occasioned by the condensation of what was, at the moment of ignition, an elastic fluid. Such a substance was always found in these cases; but when the explosion raised the weight and blew out the stopper, nothing of this kind remained.

The effects here described both of elastic force and its cessation on cooling, may evidently be referred as much to carbonic acid and perhaps other gases as to water. The strong sudden hissing observed as occurring when only a little of the products escaped, may have been due to the passage of the gases into the air, with comparatively but little water, the circumstances being such as were not sufficient to confine the former, though they

might the latter; for it cannot be doubted but that in similar circircumstances, the elastic force of carbonic acid would far surpass that of water. Count Rumford says, that the gunpowder made use of, when well shaken together, occupied rather less space than an equal weight of water. The quantity of residuum before referred to, left by a given weight of gunpowder, is not mentioned, so that the actual space occupied by the vapour of water, carbonic acid, &c., at the moment of ignition, cannot be inferred; there can, however, be but little doubt that when perfectly confined they were in the state of the substances, in M. Cagniard de la Tour's experiments *.

When allowed to remain a few minutes, or even seconds, the expansive force at first observed, diminished exceedingly, so as scarcely to surpass that of the air in a charged air-gun. Of course all that was due to the vaporization of water and some of the other products would cease, as soon as the mass of metal had absorbed the heat, and they would concrete into the hard substance found in the cylinder: but it does not seem too much to suppose, that so much carbonic acid was generated in the combustion, as would, if confined, on the cooling of the apparatus, have been equal to many atmospheres, but that being condensible, a part became liquid, and thus assisted in reducing the force within, to what it was found to be.

Ammonia.—I find the condensation of ammoniacal gas referred to in *Thomson's System*, first edition, i. 405, and other editions; *Henry's Chemistry*, i. 237; *Accum's Chemistry*, i. 310; *Murray's Chemistry*, ii. 73.; and *Thenard's Traité de Chimie*, ii. 133. Mr. Accum refers to the experiments of Fourcroy and Vauquelin, *Ann. de Chimie*, xxix. 289, but has mistaken their object. Those chemists used highly saturated solution of ammonia, see pp. 281, 286, and not the gas; and their experiments on gases, namely, sulphurous acid gas, muriatic acid gas, and sulphuretted hydrogen gas, they state were fruitless, p. 287. "All we can say is, that the condensation of most of these gases was above three fourths of their volume."

Thomson, Henry, Murray, and, I suppose, Thenard, refer to the

* See vol. xv. p. 145, of this Journal.

experiments of Guyton de Morveau, *Ann. de Chimie.* xxix. 291, 297. Thomson states the result of liquefaction at a temperature of −45°, without referring to the doubt, that Morveau himself raises, respecting the presence of water in the gas; but Murray, Henry, and Thenard, in their* statements notice its probable presence. Morveau's experiment was made in the following manner: a glass retort was charged with the usual mixture of muriate of ammonia, and quick lime, the former material being sublimed, and the latter carefully made from white marble, so as to exclude water as much as possible. The beak of the retort was then adapted to an apparatus consisting of two balloons, and two flasks successively connected together, and luted by fat lute. The balloons were empty, the first flask contained mercury, the second, water. Heat was then applied to the retort, and the first globe cooled to −21.25°C., aqueous vapours soon rose, which condensed as water in the neck of the retort, and as ice in the first balloon. Continuing the heat, ammoniacal gas was disengaged, and it escaped by the last flask containing water, without any thing being perceived in the second balloon. This balloon was then cooled to − 43.25°C., and then drops of a fluid lined its interior, and ultimately united at the bottom of the vessel. When the thermometer in the cooling mixture stood at −36.25°C., the fluid already deposited preserved its state, but no further portions were added to it; reducing the temperature again to −41°C., and hastening the disengagement of ammoniacal gas, the liquid in the second balloon augmented in volume. Very little gas escaped from the last flask, and the pressure inwards was such as to force the oil of the lute into the balloon where it congealed. Finally, the apparatus was left to regain the temperature of the atmosphere, and as it approached to it, the liquid of the second balloon became gaseous. The fluid in the first balloon became liquid, as soon as the temperature had reached −21.25°C.

M. Morveau remarks on this experiment, that it appears certain that ammoniacal gas made as dry as it can be, by passing into a vessel in which water would be frozen, and reduced to a temperature of −21°C., condenses into a liquid at the temperature of −48° C., and resumes its elastic form again as the temperature is raised;

but he proposes to repeat the experiment and examine whether a portion of the gas so dried, when received over mercury would not yield water to well calcined potash, "for as it is seen that water charged with a little of the gas, remained liquid in the first balloon, at a temperature of -21°., it is possible that a much smaller quantity of water united to a much larger quantity of the gas, would become capable of resisting a temperature of -48°C.

Sir H. Davy, who refers to this experiment in his *Elements of Chemical Philosophy*, p. 267, urges the uncertainty attending it, on the same grounds that Morveau himself had done; and now that the strength of the vapour of dry liquid ammonia is known, it cannot be doubted that M. Morveau had obtained in his second balloon only a very concentrated solution of ammonia in water. I find that the strength of the vapour of ammonia dried by potash, is equal to about that of 6.5 atmospheres at 50° F *. and according to all analogy it would require a very intense degree of cold, and one at present beyond our means, to compensate this power and act as an equivalent to it.

Sulphurous Acid Gas.—It is said that sulphurous acid gas has been condensed into a fluid, by Monge and Clouet, but I have not been able to find the description of their process. It is referred to by Thomson, in his *System*, first edition, ii. 24; and in subsequent editions; by Henry, in his *Elements*, i. 341; by Accum, in his *Chemistry*, i.319; by Aikin, *Chemical Dictionary*, ii. 391; by Nicholson, *Chemical Dictionary*, article, gas (Sulphurous acid); and by Murray, in his *System*, ii. 405. All these authors mention the simultaneous application of cold and pressure, but Thomson alone refers to any authority, and that is Fourcroy, ii. 74.

It is curious that Fourcroy does not, however, mention condensation as one of the means employed by Monge and Clouet, but merely says the gas is capable of liquefaction at 28° of cold. "This latter property," he adds, "discovered by citizens Monge and Clouet, and by which it is distinguished from all the other gases, appears to be owing to the water which it holds in solution, and to which it adheres so strongly as to prevent an accurate estimate of the proportions of its radical and acidifying principles,'

* *Philosophical Transactions*, 1823, p. 197.

Notwithstanding Fourcroy's objection, there can be but little reason to doubt that Monge and Clouet did actually condense the gas, for I have since found that from the small elastic force of its vapour at common temperatures, (being equal to that of about two atmospheres only*) a comparatively moderate diminution of temperature is sufficient to retain it fluid at common pressure, or a moderate additional pressure to retain it so at common temperature; so that whether these philosophers applied cold only as Fourcroy mentions, or cold and pressure, as stated by the other chemists, they would succeed in obtaining it in the liquid form.

Chlorine.—M. de Morveau, whilst engaged on the application of the means best adapted to destroy putrid effluvia and contagious miasmata, was led to the introduction of chlorine as the one most excellent for this purpose; and he proposed the use of phials, containing the requisite materials, as sources of the substance. One described in his *Traité des Moyens de désinfecter l'air* (1801), was of the capacity of two cubical inches nearly; about 62 grains of black oxide of manganese in coarse powder was introduced, and then the bottle two-thirds filled with nitro-muriatic acid; it was shaken, and in a short time chlorine was abundantly disengaged. M. Morveau remarks upon the facility with which the chlorine is retained in these bottles; one, thus prepared, and forgotten, when opened at the end of eight years, gave an abundant odour of chlorine.

I had an impression on my mind that M. de Morveau had proposed the use of phials similarly charged, but made strong, well stoppered, and confined by a screw in a frame, so that no gas should escape, except when the screw and stopper were loosened; but I have searched for an account of such phials without being able to find any. If such have been made, it is very probable that in some circumstances, liquid chlorine has existed in them, for as its vapour at 60° F. has only a force of about four atmospheres†, a charge of materials might be expected frequently to yield much more chlorine than enough to fill the space, and saturate the fluid present; and the excess would of course take the liquid form. If such vessels have not been made, our present

* *Philosophical Transactions*, 1823, p. 192. † *Ibid.* p. 198.

knowledge of the strength of the vapour of chlorine will enable us to construct them of a much more convenient and portable form than has yet been given to them.

Arseniuretted Hydrogen.—This is a gas which it is said has been condensed so long since as 1805. The experiment was made by Stromeyer, and was communicated, with many other results relating to the same gas, to the Gottingen Society, Oct. 12, 1805. See *Nicholson's Journal*, xix. 382; also, *Thenard Traité de Chimie*, i. 373; *Brande's Manual*, ii. 212; and *Annales de Chimie*, lxiv. 303. None of these contain the original experiment; but the following quotation is from *Nicholson's Journal.* The gas was obtained over the pneumatic apparatus, by digesting an alloy of fifteen parts tin and one part arsenic, in strong muriatic acid. "Though the arsenicated hydrogen gas retains its aëriform state under every known degree of atmospheric temperature and pressure, Professor Stromeyer condensed it so far as to reduce it in part to a liquid, by immersing it in a mixture of snow and muriate of lime, in which several pounds of quicksilver had been frozen in the course of a few minutes." From the circumstance of its being reduced only in part to a liquid, we may be led to suspect that it was rather the moisture of the gas that was condensed than the gas itself; a conjecture which is strengthened in my mind from finding that a pressure of three atmospheres was insufficient to liquefy the gas at a temperature of 0°F.

Chlorine.—The most remarkable and direct experiments I have yet met with in the course of my search after such as were connected with the condensation of gases into liquids, are a series made by Mr. Northmore, in the years 1805-6. It was expected by this gentleman "that the various affinities which take place among the gases under the common pressure of the atmosphere, would undergo considerable alteration by the influence of condensation;" and it was with this in view that the experiments were made and described. The results of liquefaction were therefore incidental, but at present it is only of them I wish to take notice. Mr. Northmore's papers may be found in *Nicholson's Journal*, xii. 368. xiii. 232. In the first is described his apparatus, namely, a brass condensing pump; pear-shaped glass re-

ceivers, containing from three and a half to five cubic inches, and a quarter of an inch thick; and occasionally a syphon gauge. Sometimes as many as eighteen atmospheres were supposed to have been compressed into the vessel, but it is added, that the quantity cannot be depended on, as the tendency to escape even by the side of the piston, rendered its confinement very difficult.

Now that we know the pressure of the vapour of chlorine, there can be no doubt that the following passage describes a true liquefaction of that gas. "Upon the compression of nearly two pints of oxygenated muriatic acid gas in a receiver, two and a quarter cubic inches capacity, it speedily became converted into a yellow *fluid*, of such extreme volatility, under the common pressure of the atmosphere, that it instantly evaporated upon opening the screw of the receiver; I need not add, that this fluid, so highly concentrated, is of a most insupportable pungency." "There was a trifling residue of a yellowish substance left after the evaporation, which probably arose from a small portion of the oil and grease used in the machine," *&c.* xiii. 235.

Muriatic Acid.—Operating upon muriatic acid, Mr. Northmore obtained such results as induced him to state he could liquify it in any quantity, but as the pressure of its vapour at 50° F. is equal to about 40 atmospheres*, he must have been mistaken. The following is his account: "I now proceeded to the muriatic acid gas, and upon the condensation of a small quantity of it, a beautiful green-coloured substance adhered to the side of the receiver, which had all the qualities of muriatic acid; but upon a large quantity, four pints, being condensed, the result was a yellowish green glutinous substance, which does not evaporate, but is instantly absorbed by a few drops of water; it is of a highly pungent quality, being the essence of muriatic acid. As this gas easily becomes fluid, there is little or no elasticity, so that any quantity may be condensed without danger. My method of collecting this and other gases, which are absorbable by water, is by means of an exhausted Florence flask, (and in some cases an empty bladder) connected by a stop cock with the extremity of the retort." xiii. 235. It seems probable that the facility of con-

* *Philosophical Transactions*, 1823, p. 198.

densation, and even combination, possessed by muriatic acid gas in contact with oil of turpentine, may belong to it under a little pressure, in contact with common oil, and thus have occasioned the results Mr. Northmore describes.

Sulphurous Acid Gas.—With regard to this gas, Mr. Northmore says, "having collected about a pint and a half of sulphurous acid gas, I proceeded to condense it in the three cubic inch receiver, but after a very few pumps the forcing piston became immoveable, being completely choked by the operation of the gas. A sufficient quantity had, however, been compressed to form vapour, and a thick slimy fluid, of a dark yellow colour, began to trickle down the sides of the receiver, which immediately evaporated with the most suffocating odour upon the removal of the pressure." xiii 236. This experiment, Mr. Northmore remarks, corroborates the assertion of Monge and Clouet, that by cold and pressure they had condensed this gas. The fluid above described was evidently contaminated with oil, but from its evaporation on removing the pressure, and from the now ascertained low pressure of the vapour of sulphurous acid, there can be no hesitation in admitting that it was sulphurous acid liquefied.

The results obtained by Mr. Northmore, with chlorine gas and sulphurous acid gas, are referred to by Nicholson, in his *Chemical Dictionary*, 8vo. Articles, Gas (muriatic acid oxygenized) and Gas (sulphurous acid); and that of chlorine is referred to by Murray, in his *System*, ii. 550; although at page 405 of the same volume, he says that, only sulphurous acid "and ammonia of these gases that are at natural temperatures permanently elastic, have been found capable of this reduction."

Carbonic Acid.—Another experiment in which it is very probable that liquid carbonic acid has been produced, is one made by Mr. Babbage, about the year 1813. The object Mr. Babbage had in view, was to ascertain whether pressure would prevent decomposition, and it was expected that either that would be the case, or that decomposition would go on, and the rock be split by the expansive force of carbonic acid gas. The place was Chudley rocks, Devonshire, where the limestone is dark and of a compact texture. A hole, about 30 inches deep and two inches in diameter,

was made by the workmen in the usual way, it penetrated directly downwards into the rock; a quantity of strong muriatic acid, equal to perhaps a pint and a half, was then poured in, and immediately a conical wooden plug, that had previously been soaked in tallow, was driven hard into the mouth of the hole. The persons about then retired to a distance to watch the result, but nothing apparent happened, and, after waiting some time, they left the place. The plug was not loosened at the time, nor was any further examination of the state of things made: but it is very probable that if the rock were sufficiently compact in that part, the plug tight, and the muriatic acid in sufficient quantity, that a part of the carbonic acid had condensed into a liquid, and thus, though it permitted the decomposition, prevented that development of power which Mr. Babbage expected would have torn the rock asunder.

Oil Gas Vapour.—An attempt has been made by Mr. Gordon, within the last few years, and is still continued, to introduce condensed gas into use in the construction of portable, elegant, and economical gas lamps. Oil gas has been made use of, and, I believe, as many as thirty atmospheres have been thrown into vessels, which, furnished with a stop cock and jet, have afterwards allowed of its gradual expansion and combustion. During the condensation of the gas in this manner, a liquid has been observed to deposit from it. It is not, however, a result of the liquefaction of the gas, but the deposition of a vapour (using the terms gas and vapour in their common acceptation) from it, and when taken out of the vessel it remains a liquid at common temperatures and pressures; may be purified by distillation, in the ordinary way, and will even bear a temperature of 170° F. before it boils, at ordinary pressure. It is the substance referred to by Dr. Henry, in the *Philosophical Transactions*, 1821. p. 159.

There is no reason for believing that oil gas, or olefiant gas, has, as yet, been condensed into a liquid, or that it will take that form at common temperatures under a pressure of five, or ten, or even twenty atmospheres. If it were possible, a small, safe, and portable gas lamp would immediately offer itself to us, which might

be filled with liquid without being subject to any greater force than the strength of its vapour, and would afford an abundant supply of gas as long as any of the liquid remained. Immediately upon the condensation of cyanogen, which takes place at 50° F. at a pressure under four atmospheres, I made such a lamp with it. It succeeded perfectly, but, of course, either the expense of the gas, the faint light of its flame, or its poisonous qualities, would preclude its application. But we may, perhaps, without being considered extravagant, be allowed to search in the products of oil, resins, coal, *&c.* distilled, or otherwise treated, with this object in view, for a substance, which being a gas at common temperatures and pressure, shall condense into a liquid, by a pressure of from two to six or eight atmospheres, and which being combustible, shall afford a lamp of the kind described*.

Atmospheric Air.—As my object is to draw attention to the results obtained in the liquefaction of gases before the date of those described in the *Philosophical Transactions* for 1823, I need not, perhaps, refer to the notice given in the *Annals of Philosophy, N.S.* vi. 66, of the supposed liquefaction of atmospheric air, by Mr. Perkins, under a pressure of about 1100 atmospheres, but as such a result would be highly interesting, and is the only additional one on the subject I am acquainted with, I am desirous of doing so, as well also to point out the remarkable difference between that result and those which are the subject of this and the other papers referred to. Mr. Perkins informed me that the air upon compression disappeared, and in its place was a small quantity of a fluid, which remained so when the pressure was removed, which had little or no taste, and which did not act on the skin. As far as I could by inquiry make out its nature, it resembled water, but if upon repetition it be found really to be the product of compressed common air, then its fixed nature shews it to be a result of a very different kind to those mentioned above, and necessarily attended by far more important consequences.

* In reference to the probability of such results, see a paper "On Olefiant Gas." *Annals of Philosophy, N.S.* iii. 37.

ART. VI. Lamarck's *Genera of Shells.*

[Concluded from VOL. XVI. p. 79.]

4th Family.

SPHÆRULATA *. (3 genera.)

Shell globular, spheroidal, or oval; whorls of the spire enveloping, or the chambers united under one covering.

The sphærulata are small, spheroidal or oval, multilocular shells, some having no other cavity than those of the chambers, and their whorls enveloping one another; others are furnished with a peculiar internal cavity, and are composed of a series of elongated, narrow, contiguous chambers, arranged in a portion of a circle, which, by their union, form a single coat, that envelopes the central cavity.

1. Milliolites †.

Shell transverse, oval-globular, or elongated, multilocular; chambers transverse, surrounding the axis, and successively covering one another; aperture very small, situated at the base of the last whorl, orbicular, or oblong.

Lamarck states that he possesses some milliolites, (or rather *milliolitæ*,) in the recent state, which were found on fuci, near the Island of Corsica; but all the species he describes are fossil. In that state they occur in such vast abundance as to form the principal part of the stony masses of some of the quarries near Paris.

The size of these tiny shells scarcely exceeds that of grains of millet (whence their name); some are globular, inclining to oval, others oblong, or somewhat triangular. Their spire turns round an axis perpendicular to the plane of the whorls, and much longer than the transverse, or horizontal diameter of the shell; which is just the reverse of what takes place with the planorbes, ammonites, &c. The chambers, which are considerably broader than

* From *sphærula*, a little ball. † From *millium*, millet.

they are long, are transverse, envelope the whole length of the axis, and cover one another in succession, giving the shell a triangular form, three chambers being rather more than sufficient to complete a whorl.

Type. *Milliolites cor anguinum**.

Shell subcordate, inflated, duplex; aperture small, suborbicular. Fossil, Grignon. Pl. vi. Fig. 220. 4 Species †.

2. Melonites ‡.

Shell subspherical, multilocular; spire central; whorls contiguous, enveloping, tuniciform. Chambers narrow, elongated, and numerous; septa imperforate.

Type. *Melonites sphærica* §.

No further description. Pl. vi. Fig. 221. 2 Species.

5th Family.

RADIOLATA ‖. (3 genera.)

Shell discoidal, spire central; chambers elongated, radiating from the centre to the circumference.

From the character of the shells of this family, it follows that their spire can have but one turn, and is consequently false, or imperfect.

1. Rotalites ¶.

Shell orbicular, spiral, convex or conoidal at the upper part; flattened, radiating, and tubercular, at the lower; multilocular. Radii wavy. Aperture marginal, triangular, inclined towards the base.

The rotalites are very small shells, widest at the base, with the whorls contiguous and distinct. The transverse septa which di-

* Serpent's heart.

† We omit the genus *gyrogonites*, altogether, on the authority of M.M. Cuvier and Brogniart, quoted below. The truth of Leman's observation, has since been confirmed by Mr. Sowerby. The passage alluded to will be found at page 61, of the *Description Geologique des Environs de Paris*. Speaking of the fossil shells of the third fresh-water formation, Messrs. B. and C. add, " There are also found in it those small, round, channelled bodies, which M. de Lamarck has named *gyrogonites*, and which, according to M. Leman's observations, appear to be the seed of a species of *chara*."

‡ From *melo*, a melon. § *Spherical*. ‖ From *radius*, a ray.

¶ From *rota*, a wheel.

vide the chambers, radiate from the centre or axis of the shell towards the circumference, so that the chambers are slightly conical.

One species. *Rotalites trochidiformis**.

Shell conoidal; whorls carinate; lower side granular. Fossil, Grignon. Pl. vi. Fig. 222.

Lenticulites†.

Shell sublenticular, spiral, multilocular; exterior margin of the whorls triplicate, extending over the interior whorls, both above and below, to the centre of the shell. Septa entire, curved, produced on both sides like radii. Aperture narrow, projecting over the penultimate whorl.

The lenticulites are distinguished from the rotalites and discorbites, by the lateral prolongation of the chambers and septa, and from the nautilus, by not having the siphon of that shell. They are very similar in structure to the nummulites, but they differ from them by the prolongation of the chambers, *&c.*, and by the projection of the aperture over the penultimate whorl. They are chiefly found in the fossil state, but Lamarck tells us that he possesses some recent species of this genius, which were found in the sea near Teneriffe, at the depth of 125 feet. He describes only three fossil species, but adds in a note, that the *nautilus calcar*, and *nautilus crispus*, of Gmelin, as well as the *nautilus calcar* of Fichtel, appear to be distinct species of lenticulinæ, and must be added to those he has described.

Type, *Lenticulites rotulata*‡.

Shell orbicular; margin acute; discs somewhat gibbous on both sides. Fossil, Meudon. Pl. vi. Fig. 223.

3. Placentula§.

Shell orbicular, discoidal, convex above and below, multilocular; aperture oblong, narrow, lying like the radius of a circle on the lower disc, or on both discs.

The placentulæ are divided internally into several chambers,

* *Trochus-shaped.* † *Lenticula*, a little lentil.
‡ From *rotula*, a little wheel. § A little cake.

each extending from the centre to the circumference. Their aperture is the chief character which distinguishes them from the lenticulites.

Type. *Placentula pulvinata* *.

No further description. Pl. vi. Fig. 224. 2 Species, both recent.

6th Family.

NAUTILACEA. (6 genera.)

Shell discoidal, spire central, chambers short, not extending from the centre to the circumference.

The nautilacea differ widely from the radiolata, in having the spire composed of several whorls, wherefore the chambers cannot extend from the centre to the circumference: their spire is also complete, which that of the radiolata never is.

1. Discorbites †.

Shell discoidal, spiral, multilocular; sides simple. All the whorls visible, naked, contiguous to one another. Septa transverse, frequent, imperforate.

The discorbites differ from the nautili, by having all the whorls of the spire visible, and no siphon: from rotalites, by the aperture not inclining downwards towards the base, and the spire not rising into a cone.

One species. *Discorbites vesicularis* ‡.

Shell discoidal; whorls nodular at the chambers, subvesicular; last chamber somewhat closed. Fossil, Grignon. Pl. vi. Fig. 225.

Note, by Lamarck. The *Cornu ammonis vulgatissimum* of Plancus, (de Conch. Arimin. p. 8. t. 1. f. 1.) must be referred to this genus.

2. Siderolites

Shell multilocular, discoidal; whorls contiguous, not visible externally; disc convex on both sides, and loaded with tubercular points; circumference bordered with unequal radiating lobes. Septa transverse, imperforate. Aperture distinct, sublateral.

The siderolites are very small, star-shaped shells, with a sub-

* *Made like a cushion, or pillow.* † From *discus*, a disk, and *orbis*, an orb.
‡ *Vesicular.* § From *sidus*, a star.

granular disc, and the circumference beset with several unequal points, diverging like radii.

One species. *Siderolites calcitrapoides**.

A small shell, very remarkable for its star-shape; it is subpapillous, with unequal projecting radii, with blunt points. Fossil, Maëstricht. Pl. vi. Fig. 226.

3. Polystomella†.

Shell discoidal, multilocular; whorls contiguous, not visible externally; their surface radiated by transverse furrows or ribs. Aperture composed of several foramina, variously disposed.

The polystomellæ are radiated externally by the projection of the transverse septa of the chambers, which extend from the summit to the circumference of the shell, crossing the whorls, which are not visible on the outside. These characters are common also to the lenticulites, but the aperture of the latter is simple, whilst that of the polystomella is composed of several holes, differently disposed in the different species.

Type. *Polystomella crispa*‡.

No further description. Pl. vi. Fig. 227. 4 Species, all recent.

4. Vorticialis §.

Shell discoidal, spiral, multilocular; whorls contiguous, not visible externally; septa transverse, imperforate, not extending from the centre to the circumference. Aperture marginal.

The vorticiales differ from the nummulites chiefly by having a distinct aperture, and from the discorbites, by the spiral whorls not being visible externally. Their axis is central, and confounded with the summit of the spire.

Type. *Vorticialis craticulata*¶.

No further description. Pl. vi. Fig. 228.

5. Nummulites ‖.

Shell lenticular, attenuated towards the edges; spire internal, discoidal, multilocular, covered with several thin plates; exterior

* Like the rowel of a spur.

† From πολυς, many, and στομα, a mouth.

‡ Curled.

§ From *vortex*, a whirlpool?

¶ From *craticula*, a gridiron?

‖ From *nummulus*, a small coin.

side of the whorls triplicate, extending from both sides to the centre of the shell, and uniting. Chambers very numerous, small, alternate; septa imperforate, transverse.

The nummulites, by a transverse section in the direction of their plane, present from eighteen to twenty-four very narrow whorls, which seem to turn circularly round a central point, yet, nevertheless, describe a true spiral line, terminating in the last whorl; and since each of them is doubly folded at its exterior margin, they form as many little plates, above and below, as there are whorls, which all unite at the two centres. Now, between all these little plates, each whorl of the spiral is divided into a multitude of small chambers, formed by transverse, imperforate septa, extending rather obliquely towards the centre of each disc, losing themselves and disappearing between the plates, as they approach each other. Hence the shell is thickest in the middle.

Breyn, in 1732, and *Jean Gesner*, in 1758, conceived the idea that the nummulites are true univalve shells, very analogous to the ammonites, and Bruguières has since adopted their opinion, of the accuracy of which there can now be little question. They are very common fossils, and extremely abundant in various countries, often forming large stony masses. Bruguières considers them to be sea shells.

Type. *Nummulites lævigata**.

Shell lenticular, smooth, slightly convex on both sides.

Fossil, Villers-Coterets. Pl. vi. Fig. 229. 4 Species, all fossil.

6. Nautilus †.

Shell discoidal, spiral, multilocular; parietes simple, without any suture. Whorls contiguous; the last enveloping the others. Chambers numerous, narrow, transverse, formed by transverse septa; last chamber very large; septa concave on the side next to the aperture, their discs perforated by a tube, and their margins very simple.

The nautilus is generally rather a large shell, whose spire turns orbicularly in the same plane, round the central summit. A por-

* Smooth. † The original name, from *nauta*, a sailor.

tion of the last whorl seems to be enveloped by the posterior part of the sack or mantle of the cephalopodous animal to which it belongs, the remainder of the shell being uncovered and visible; whilst another part of the animal is contained in the last chamber of the shell, to which it probably adheres by a tendinous ligament, inserted in the extremity of the siphon *. The want of colour at the end of the last whorl, confirms this supposition.

Type. *Nautilus pompilius* †. (Idem. *Linn.*)

Shell suborbicular, marked with red streaks; whorls smooth at the back and sides; aperture oblong-cordate; umbilicus concealed. *Indian Ocean.* Pl. vi. Fig. 230. 2 Species, both recent.

7th Family.

AMMONEATA. (5 genera.)

Septa sinuous, lobed and indented at the circumference, united at the inner surface of the shell, and articulating with it by means of indented sutures.

The multilocular shells of this family are very remarkable for the character of their septa, whose wavy and sinuous discs, lobed and indented at their circumference, form, by their union, as they fold back at their junction with the inner surface of the shell, a sort of indented sutures, not unlike the leaves of the parsley. These suture sare hidden by the exterior portion of the shell; but, although we usually find the ammoneata in the fossil state, after the shell has disappeared, still their casts display, in a very evident manner, the peculiar characters of the family.

Of the animals belonging to these shells we know nothing; but from their being multilocular, we presume, with great probability, that they are cephalopoda, and analogous to the nautili, though at the same time very distinct from that genus. It seems probable that the shell is wholly internal, and, as Bruguières has supposed, that most of them live at great depths in the ocean.

The general form of these multilocular shells varies extremely

* A similar confirmation, there is every reason to suppose, must belong to the ammonites, nummulites, &c. See what has been already said on this subject under the head *Spirula*.

† From πομπίλος, whence *pompilus*, a term used by Pliny, for a species of nautilus.

in the different genera. Some are discoidal, with spiral whorls either visible or enveloping; some form a turrited, pyramidal spire; whilst others are straight, or nearly so, without any spire at all.

1. Ammonites*.

Shell discoidal, spiral, whorls contiguous, and all of them visible; the interior parietes articulated by sinuous sutures. Septa transverse, lobed and indented at the circumference; their discs without any siphon, but perforated by a sort of marginal tube.

The ammonites differ essentially from the nautili, by the sinuous sutures of the internal parietes, and by the similarly sinuous form of the septa. From the orbulites, by all the whorls being distinctly visible.

The ammonites are only known in the fossil state, and most of the specimens, found in our collections, are merely internal pyritic casts of the shells. They are common in almost all countries, chiefly in schistose or argillaceous formations, and M. Ménard found one in the maritime Alps, at an elevation exceeding 9000 feet. Several species are of very large size. They abound so much in Burgundy, that the road between Auxerre and Avalon is mended with ammonites.

Type. *Ammonites Königi*†.

Shell discoid, convex, with radiating undulations; inner whorls half exposed; marginal undulations numerous; central undulations few, very prominent; aperture cordate elongated. Pl. vi. Fig. 231. From Kelloways‡.

2. Orbulites§.

Shell subdiscoidal, spiral, whorls contiguous, the last envelop-

* From *ammon*, a name of Jupiter, who was worshipped in Libya under the form of a ram. The old name of the ammonites was *cornu ammonis*, from their resemblance to a ram's horn.

† Named in honour of Mr. König.

‡ Our figure, and the preceding specific character, is taken from the Mineral Conchology of the late James Sowerby, Esq., in whose lamented death natural history has recently experienced a severe loss. The talents and ardour of his sons, happily forbid our deploring it as irreparable.

Lamark describes 20 species of ammonites, but he has not given a single refence to any other author, or to any figure, for either of the species described.

§ From *orbis*, an orb.

ing the rest; internal parietes articulated by sinuous sutures. Septa transverse, lobed at the circumference, and perforated by a marginal tube.

Type. *Orbulites subradiatus* *. (Ammonites subradiatus. *Sowerby.*)

Shell lenticular, umbilicated, carinated and radiated; radii twice curved, obscure, excepting near the margin, where they are bifid; umbilicus small; keel entire; aperture sagittate.

From a mass of olite, found on the road between Bath and Bristol. Pl. vi. Fig. 232.

3. Ammonoceratites †.

Shell corniform, arched, subsemicircular; parietes articulated by sinuous, ramose, indented sutures. Septa transverse, sinuous, lobed and indented at the circumference. Tube or siphon marginal, not perforating the septa.

The ammonoceratites seem to be to the multilocular shells with indented septa, what the spirula is to those with simple septa. In either case the whorls of the spire are not contiguous, and the present genus appears not even to form one complete whorl. The upper extremity is flattened at the sides, so as to become linguiform.

Type. *Ammonoceratites glossoidea* ‡.

Shell very large, thick, cylindrical, arched, rather flat at the sides, inner side somewhat concave; apex compressed, linguiform. Said to be found in India. Pl. vi. Fig. 233.

* *Subradiated.* Our figure is from a specimen lent us by our kind friend Mr. G. B. Sowerby, and which has been drawn and described in the 5th vol. of the Mineral Conchology. Lamarck has described five species of orbulites, but given no reference to any figure of either of them, except to a doubtful one of the third, *O. striata.* We have adopted Mr. Sowerby's specific name and description of the specimen we have figured, which does not belong to either of the five species mentioned by Lamarck.

† From Αμμων, ammon, and κερας, a horn.

‡ From γλωσσα, a tongue, and ειδος, form. Our figure is copied from that in Bowdich's Elements of Conchology, who calls it *A. Lamarckii*, and says, in a note, "The locality is unknown. M. Lamarck purchased it by accident: he kindly allowed me to take it home, in order that the figure, which is the first that has been made, might be as accurate as possible." Part I. p. 21.

The shell has been broken in three pieces, as shewn in the figure. Its length is 19 inches, 2 lines. (*French* measure.) 2 Species.)

4. Turrilites *.

Shell spiral, turrited, multilocular, whorls contiguous, all visible; parietes articulated by sinuous sutures. Septa transverse, lobed and indented at the circumference. Aperture rounded.

The turrilites, instead of being discoidal, or simply arched, are elongated, straight, and form a very elevated spiral, which, it seems, must terminate in a point, like the turritella. Fragments of internal casts of this shell have been long known by the name of *turbinites.* We are indebted for a more accurate knowledge of the genus to M. Denis Montfort.

One species. *Turrilites costutala* †.

Shell straight, turrited; whorls convex, transversely ribbed; ribs tubercular at the extremities. *St. Catherine's Hill, near Rouen.* Pl. vi. Fig. 234.

5. Baculites ‡.

Shell straight, cylindrical, sometimes slightly compressed, rather conical; parietes articulated by sinuous sutures. Septa transverse, near together; disc of the septa imperforate, lobed and indented at the circumference.

The chambers of these shells, of which we have only the internal casts, are narrow, transverse, and differ in that respect from those of the turrilites, which are rather longitudinal, the septa which form them b[illegible] farther asunder. In both, the chambers are filled with [illegible] matter.

Type [illegible] *Baculites Faujasii* §.

Shell straight, cylindrical, slightly depressed at the opposite sides; sutures lobed, indented. *St. Peter's Mount, near Maëstricht.* Pl. vi. Fig. 235. 3 Species.

SECTION II.

Monothalamous Cephalopoda. (1 Genus.)

Shell unilocular, wholly external, and enveloping the animal.

* From *turris*, a tower. † Ribbed. ‡ From *baculum*, a staff.
§ In honour of M. Faujas.

It is a very extraordinary circumstance that an animal, whose body is not in the slightest degree spiral, should form a spiral shell. The fact, however, is well ascertained, as the animal has been seen in its shell, and Lamarck states that he has seen it so himself. The curvature of the shell arises, he thinks, from the way in which the animal folds and rolls up some of its arms, when at rest within it. In the cephalopoda of the first section the portion of the body of the animal, enclosed by the shells, is contained in the last chamber; in this, the whole animal is enveloped by the shell.

The shell of the monothalamous cephalopoda is univalve, unilocular, wholly external, and capable of floating on the surface of the water. It is thin and fragile, and seems to have some analogy with that of the carinaria; but the animal, to which that shell belongs, is not a cephalopoda.

One genus. *Argonauta**.

Shell univalve, unilocular, involute, very thin; spire bicarinated, turning into the aperture; carinæ tubercular.

The animal of the argonauta has a fleshy body, like the octopus, obtuse below, and principally contained in a non-alated sac, formed by the mantle. The head is furnished with lateral eyes, and terminated by the mouth, around which are ranged, like radii, eight elongated pointed arms, furnished with suckers. Two of these arms have, for two-thirds of their length, a thin, oval membrane, which the animal extends and contracts at pleasure.

The difference between this animal and the octopus, consists principally in the singular membrane just mentioned, and in the latter having no shell.

The argonauta does not appear to be attached to its shell, and it is said that it quits it when it pleases. It is asserted, moreover, that when it wishes to sail on the surface, it displaces the water from the shell, in order to lighten it, extends the two membranous arms, which serve as sails, and plunging the others in the sea, they perform the office of oars. If bad weather, or an enemy approach,

* From *argo*, the name of the ship which carried Jason from Thessaly to Colchis, and *nauta*, a sailor. Lamarck observes, that the genus *ocythoe*, of Leach, ought, perhaps, to be included in this section.

in an instant all is taken in; the animal ships his oars, strikes his sails, and upsets his boat, which fills with water and goes down: but when the danger is past, he returns to the surface, bends his sails again, and once more rows gallantly along.

> "The tender nautilus, who steers his prow,
> The sea-born sailor of his shell canoe,
> The ocean Mab, the fairy of the sea,—
> * * * * * * * *
> He when the lightning-winged tornadoes sweep
> The surge, is safe—his port is in the deep. BYRON.

Recent observations have vindicated the character of this clever little sailor from the aspersions heretofore cast on it, of being a mere pirate, who having killed and devoured the former inhabitant, seizes on his vessel: they have proved that he is lawful owner, and his own industrious shipwright—and beautiful is the model which his little frail bark is constructed! It somewhat resembles a nautilus in its external form, whence its trivial name, *paper nautilus*; but it is essentially different from that shell, in being unilocular. It is, besides, very thin, externally rugose or tubercular, and furnished with a double keel. The end of the spire always turns inwards and enters the cavity, and the last whorl envelopes all the others. The argonautæ are found in the Mediterranean, and East Indies.

Type. *Argonauta argo.* (Idem. *Linn.*)

Shell large, involute, very thin, white; sides transversely ribbed; ribs frequent, forked on one side; carinæ approximate, tubercular, partially blackish red; tubercles small, very numerous. *Mediterranean.* Pl. vi. Fig. 236. 3 Species, all recent.

SECTION III.

Naked Cephalopoda. (1 Family.)

The animals of this section have no shell, either internal or external, but the greater number of them contain a solid, free, cretaceous or horny substance in the interior of their body.

Sepiaria. (4 Genera.)

This family includes all the animals which Linneus comprehended under one generic name, *sepia;* they are the most perfectly known of all the cephalopodous mollusca.

The sepiaria are marine animals, none of them have any true shell, they always live in the sea, some crawling at the bottom, as the octopus, others, as the sepia and loligo, swimming freely in mid water, by means of the membranes or fins with which their sac is furnished.

The body of these animals is fleshy, half enclosed in a muscular sac, from which the head and anterior part of the body project. The head is crowned with tentacular arms, disposed like radii round the mouth, with suckers on the inner side. The branchiæ are enclosed in, and concealed by, the sac, on the outside of the peritoneum which contains the viscera. They are two in number, of a pyramidal form, and are situated one on each side of the peritoneum. The containing cavity has an external communication by the funnel under the neck, at the mouth of the sac, and which conveys the water to and from the branchiæ.

1. Octopus *.
2. Loligopsis.

The second of these genera is wholly unprovided with any solid cretaceous or horny substance in the interior of its body, but the octopus has two cartilages inserted in the substance of the purse, or elongated sac, which partly contains the body. Cuvier describes these cartilages as having the form of a dagger, (*stilets*,) and says that they occupy the lower half of each side of the back, and are the only appearance of any thing resembling the sword of the calmar, (*Loligo*,) or the bone of the sepia. *Hist. et Anatom. des Mollusques*, p. 12.

The general form of the octopus is very analogous to that of the sepia and loligo; it has eight long, nearly equal arms, surrounding the mouth; no membranes for swimming attached to the sac, and the suckers are simply fleshy, and not provided with the horny indented ring, which constitutes the claw of the latter animals. They are the largest of the sepiaria. The loligopsis has eight sessile and equal arms, round the mouth; two fins, or membranes, for swimming, attached to the lower part of the sac, and is of

* From ὀκτὼ, eight, and πους, a foot.

small size. Only one species, *Loligopsis Peronii*, is known. Of the octopus, Lamarck describes four species.

3. Loligo*.

Body fleshy, contained in an elongated cylindrical sac; sac pointed at the base, and alate at the lower part. An elongated, thin, transparent, horny lamina, enclosed in the interior of the body, near the back. Mouth terminal, furnished with strong horny mandibles, like a parrot's bill, and surrounded by ten arms; arms furnished with suckers, with circular, cartilaginous rings, with simple edges; two of the arms longer than the rest, and pedunculated.

The loligo is distinguished from the sepia, by its sac being narrower, and furnished with the membranes for swimming at the posterior part only; whereas that of the sepia, which is very much broader, has a narrow ala, or fin, on each side, extending from the upper margin to the base of the sac. A still more striking difference between the two genera, is derived from the sword, or simple, feather-shaped, horny, transparent, dorsal lamina, belonging to the loligo, which, in every respect, is wholly unlike the lamellar, spongy bone of the sepia.

The internal organization of the two animals is very similar; each secretes a black liquor, which it can eject at pleasure, and probably on similar occasions. The loligines swim at freedom in the sea, and prey on crabs and other marine animals. They deposit their eggs in clusters, like a bunch of grapes, all being attached to a common centre, and forming an orbicular mass.

Type. *Loligo vulgaris*†. (Sepia loligo. *Linn.*)

Alæ semirhomboidal, separate to the extremity of the tail; border of the sac trilobate; dorsal lamina contracted anteriorly. *European Seas.* Pl. vi. Fig. 237.

4. Sepia‡.

Body fleshy, depressed, contained in a sac; sac obtuse posteriorly, and bordered on each side, through its whole length, by a

* Original Latin name for a species of cuttle fish.

† Common.

‡ From *sepio*, to cover, or conceal, because it conceals itself, when pursued, by the ejected inky fluid.

narrow ala. A free, cretaceous, spongy, opaque bone, enclosed in the interior of the body, near the back. Mouth terminal, surrounded by ten arms, furnished with suckers; two of the arms pedunculated, and longer than the others.

The bone enclosed in the body of the sepia, is friable, light whitish, oval, rather thick in the middle, thin and sharp at the edges. It is composed, according to Cuvier, of thin laminæ, in the interstices of which are a multitude of small hollow columns, perpendicular to the laminæ.

The sepiæ attain a considerable size; some are nearly two feet long. The head, which, with the upper part of the body of the animal, projects beyond the sac, has two large, very remarkable eyes, placed at the sides, and which are the most perfect of those of any of the invertebrated animals; except that they have no eyelids, they appear to be as perfect as the eyes of vertebrated animals. The suckers at the summit of the long arms, serve to keep the animal stationary, whilst it seizes its prey with the shorter ones, which are also furnished with suckers, and are conical, pointed, and rather compressed at the sides. The form of the suckers, when extended, is "nearly that of an acorn cup, with a deep circular cartilaginous ring, armed with small hooks, which is secured in a thin membrane, something transparent by the projection of a ledge; investing its whole circumference about the middle of its depth, and not to be extracted without some force.

"Each sucker is fastened by a tendinous stem to the arm of the animal; which stem, together with part of the membrane that is below the circumference of the cartilaginous ring, rises into, and fills its whole cavity, when the animal contracts the sucker for action. In this state, whatever touches it, is first held by the minute hooks, which insinuate themselves betwixt the scales of its prey, and then is drawn up to a closer adhesion, by the retraction of the stem, and inferior part of the membrane, much in the same manner as a sucker of wet leather sustains the weight of a small stone*." The mouth of the sepia is situated at the summit of the

* Needham on the Calamary, p. 22. 1745.

head, in the centre of the arms; its orifice is circular, membranous, more or less fringed, and contains internally two hard, horny mandibles, similar in form and substance to those of a parrot's bill, which are hooked, and shut one into the other. Within the cavity of the beak is a membrane, furnished with several rows of small unequal teeth. With this formidable weapon, the sepia devours crabs, lobsters, and even shell-fish, which it crushes with its beak, and then completes their trituration in its muscular stomach, which almost resembles the gizzard of a bird.

The bladder which contains the black fluid, called the *sepia ink*, is placed near the *cœcum;* it is connected with the extremity of the intestinal canal by a small tube, and terminates at the anus, whose orifice opens into the funnel at the anterior part of the body of the animal. By this canal the sepia ejects the inky fluid contained in the bladder, when pursued by an enemy, and escapes the threatened danger, by the obscurity it imparts to the surrounding water. It is said that the indian ink is prepared from the black fluid of some species of sepia.

The sepiæ are not hermaphrodite, like most of the other mollusca, but consist of male and female individuals; the latter lay clusters of soft eggs, connected together like a bunch of grapes. They are supposed at first to be yellowish, and to become blackish after they are fecundated.

Type. *Sepia officinalis**. (Idem. *Linn.*)

Body smooth on both sides; pedunculated arms very long; dorsal bone elliptical. *Mediterranean, English Channel,* &c.†. Pl. vi. Fig. 238. 2 Species.

Fifth Order.

Heteropoda. (3 Genera.)

Body free, elongated, swimming horizontally. Head distinct; two eyes. No coronet of arms on the head, nor foot under the belly or neck, for creeping. One or more membranes for swimming, not disposed in regular order, nor in pairs.

* Of the shops.

† In some former instances, *la manche,* (the channel,) has inadvertently been written *la mancha.*

The situation of the heart and branchiæ of the mollusca of this order, is extremely singular; they are placed below the belly, and in many of them are on the outside of it. In this respect, and in the position of the animal whilst swimming, which is horizontal, the heteropoda differ essentially from the pteropoda, which always float in a perpendicular position.

They seem to be more nearly allied to the cephalopoda, but differ from them by having no arms on the head, no mantle, nor the two horny, crooked mandibles, like a parrot's bill, which those animals are furnished with: their organs of motion are also differently disposed.

The body of these mollusca is gelatinous and transparent, and the shell of some of them resembles that of the argonauta.

1. Carinaria *.

Body elongated, gelatinous, transparent, terminated posteriorly by a tail, and furnished with one or several unequal alæ. Heart and branchiæ projecting beyond the belly, united in a pendant mass, situated towards the tail, and enclosed in a shell. Head distinct; two tentacula; two eyes; a contractile trunk.

Shell univalve, conical, flattened at the sides, unilocular, very thin, hyaline; summit convolute, spiral; back of the shell sometimes furnished with an indented keel. Aperture oblong, entire.

M. Bory de St. Vincent first observed this singular animal in his voyage to the principal islands of the African seas, and gave a figure of it, with its shell enclosing the principal organs. Subsequently MM. Peron and Le Sueur have given further details of the animal, in the *Annales du Museum*, vol. xv. p. 67.

Type. *Carinaria vitrea* †. (Patella cristata. *Linn.*)

Shell thin, hyaline, transversely sulcated; back furnished with an indented keel; spire conoidal, attenuated; apex very small, involute; aperture contracted towards the keel. *Southern Ocean.* Pl. vi. Fig. 239.

This shell, which M. Lamarck considers as the rarest, most curious, and most precious of all that are contained in the Museum of Natural History at Paris, was presented to it by M. de la Réveillère, Lépaux, in the name of M. Huon, who, after the death of Entre-

* From *carina*, the keel of a vessel. † Glassy.

casteaux, commanded the expedition sent in search of La Peyrouse. It is distinguished from the argonauta, by the spiral summit not entering into the aperture, and by its having a single, sharp, indented keel, the whole length of the back. The animal, moreover, never conceals itself in the shell, which, probably, serves only to protect the heart and branchiæ, which are enclosed within it.

Lamarck gives two other species, *viz.*, C. fragilis, from the African Seas, and C. cymbium, (*argonauta cymbium. Linn.*) from the Mediterranean; the latter no larger than a grain of sand.

2. Pterotrachea.

3. Phylliroe.

These genera, the last of the mollusca, have no shell.

In parting with our author, we cannot but congratulate and thank him for the essential service he has rendered the science by his admirable work. In his hands conchology has assumed its proper aspect, and from being little better than a vague mass of unconnected descriptions, now forms a regular and important link in the great chain of natural history: If his system be not absolutely faultless, it is at least superior to any other general system extant. In one or two instances, perhaps, Lamarck may have constituted a genus, from characters not sufficiently peculiar to entitle the individual to that distinction. His castalia, for instance, seems to be separated from the unio on insufficient grounds; and Mr. G. B. Sowerby has, we think very properly, restored it to that genus. Indeed, our author himself appears to have had some doubt on the subject, from the specific name *ambigua,* by which he denominates it.

In point of nomenclature, the work contains some grammatical inaccuracies and inelegancies, which have occasionally surprised us. The names are frequently taken from obsolete Latin terms, when better words might, just as easily, have been adopted, and much confusion prevails in the genders assigned to several of them. Thus, diceras, derived from a Greek neuter noun, is made eminine; pterocera, similarly derived, should be pteroceras, and neuter; as should anostoma, but, like diceras, they are both made

feminine. Planaxis and argonauta, which are made feminine, should be masculine; as should alto triton, which is made a neuter noun. Other similar oversights may be found, but our limits will not allow us to extend the list, even if we were so inclined; and, after all, the faults are so overbalanced by the merits, that, *non paucis offendemur maculis.* We once more thank M. de Lamarck for the treasure he has given to the world, and heartily bid him farewell.

P. S.—It will be seen by the list of plates, that, in the last we have given the figures of most of these shells, of which we were not able to obtain drawings at an earlier period. Except clymene, to which Lamarck gives no reference but the manuscript memoirs of M. Savigny, we believe every genus is now illustrated by an appropriate figure. We have also given a second figure of planaxis sulcatus, and another of carocolla acutissima, from more characteristic specimens than those from which our former drawings were taken. The figure of the limacina helicialis is from a specimen brought to England by Captain Sabine, who accompanied Captain Ross on his expedition to the Arctic Regions. It perfectly answers Lamarck's description of that shell, and also the figure referred to by Otho Fabricius, in his Fauna Gröenlandica, which may be found in Adelung's *Geschichte der Schiffahrten*, or History of Voyages to discover a north-east passage to Japan and China, Hallè, 1768. Pl. xvii. Fig. 12.

The following is Mr. Sowerby's specific character of the *galeolaria decumbens*, (Fig. viii. ***.) "Testâ repente, teretiuscula, dorso obtusè angulato, sulcato, aperturæ lingulâ breviusculâ." We have not been able to obtain either of the two species described by Lamarck, if, indeed, they be really different from the G. decumbens, of Sowerby. Lamarck gives no reference to any figure for either of his species.

Fig. xii.* is *creusia spinulosa;* that described at p. 76, vol. xiv. *C. stromia*, we have not met with; we, therefore, add the specific character of *C. spinulosa.*

Shell turbinated, convex, with four sutures; furrows very small, radiating, spinous.

EXPLANATION OF THE PLATES.

N. B. All the Figures are drawn from Nature, except those stated to have been copied from other Works.

Plate 3. Vol. 14.

Fig.
1. Siliquaria anguina.
2. Dentalium elephantinum.
3. Pectinaria belgica.
4. Sabellaria alveolata. (*Ellis. Tubularia arenosa Anglica.*)
5. Terebella conchilega. (*Ency. Method.* Pl. 67. Fig. 5.
6. Amphitiiti ventilabrum. (*Ellis.* Pl. 34.
7. Spirorbis nautiloides.
8. Serpula vermicularis. (*Ellis.* Pl. 38. Fig. 2.
9. Tubicinella balænarum. *a.* operculum.
10. Coronula diaderna. Upper and under view.
11. Balanus sulcatus.
12. Acasta Montagui. (*Encycl. Britan. Sup.* Vol. 3. Pl. 1. Fig. 57.)
13. Pyrgoma cancellata, exterior and interior view of the shell, with the valves of the operculum below.
14. Anatifa levis.
15. Pollicipes cornucopiæ, the smaller figure shews the tentacular arms.
16. Cineras vittata.
17. Otion Cuvieri.
18. Aspergillum javanum.
19. Clavagella echinata. (*Annales du Museum.* Vol. 12 Pl. 43. Fig. 9. *a.*)
20. Fistulana clava. *a. b.* the interior valves.
21. Septaria arenaria. *b.* small end, shewing the septum. *c.* large end.
22. Teredina personata. (*An. du Mus.* Vol. 12. Pl. 43. Fig. 6.)

Plate 4. Vol. 14.

Fig.
23. Teredo navalis. *a.* interior of the tube, shewing the transverse septa. *b.* the true shell. *c.* its two valves. *d.* the operculiferous pieces.
24. Pholas dactylus. *a.* interior of one of the valves, shewing the internal, dentiform process, below the umbo.
25. Gastrochæna cuneiformis.
26. Solen vagina. upper fig. exterior; lower, interior view.
27. Panopæa Aldrovandi, exterior and interior.
28. Glycimeris siliqua. *a.* interior of one valve.
29. Mya truncata. *a.* interior of the right valve. *b.* interior of the left valve
30. Anatina laterna, exterior and interior.
31. Lutraria solenoides. do. do.

Plate 5. Vol. 14.

Fig.
32. Mactra gigantea, exterior and interior.
33. Crassatella Kingicola, 33 and 33. *a.* interior of each valve. *b.* exterior of the valves united. (*Sowerby's Genera of Recent and Fossil Shells.*)
34. 34. *a.* Erycina cardioides, exterior and interior.

Fig.
34. *b.* and 34. *c.* Erycina complanata, exterior and interior.
35. Ungulina transversa, exterior and interior.
36. Solenomya mediterranea, do. do.
37. Amphidesma variegatum, do. do.
38. Corbula nucleus, do. do.
39. Pandora rostrata. *a.* interior of right valve. *b.* ditto left.
40. Saxicava rugosa, exterior and interior.
41. Petricola striata, do. do.
42. Venerupis perforans. *a.* interior of right valve. *b.* ditto left.
43. Sanguinolaria rosea, exterior and interior.
44. Psammobia ferroensis. *a.* interior of left valve. *b.* ditto right.
45. Psammotea donacina, exterior and interior.
46. Tellina radiata, do. do.
47. Corbis fimbriata, valves united, shewing the relative position of the umbones. *a.* exterior of one valve. *b.* interior do.
48. Lucina Jamaicensis. exterior and interior.
49. Donax scortum. side view, shewing the lunula. *a.* exterior of one valve. *b.* interior ditto.
50. Capsa lævigata. exterior of one valve. *a.* interior of left valve. *b.* ditto right valve.

Plate 6. Vol. 14.

Fig.
8.*. Magilus antiquus.
46.*. Tellinides timorensis. *a. b.* the two hinges. (*Bowdich's Elements of Conchology.* Fig. 36. *a. b.*)
51. Crassina Danmoniensis. *a.* interior of left valve. *b.* ditto of right do.
52. Cyclas rivicola. exterior and interior.
53. Cyrena cor. exterior and interior.
54. Galathea radiata. *a. b.* interior of right and left valves.
55. Cyprina Islandica. exterior and interior.
56. Cytherea lusoria. exterior of one valve. *a.* back view of the valves united. *b.* interior of right valve.
57. Venus puerpera. exterior and interior.
58. Venericardia planicosta.
59. Cardium costatum. exterior and interior.
60. Cardita sulcata. do. do.
61. Cypricardia Guinaica. do. do.
62. Hiatella spinosa. *a.* left valve. *b.* right valve.
63. Isocardia cor. side view of the valves united. *a.* exterior of one valve. *b.* interior of do.
64. Cucullæa auriculifera. exterior and interior.
65. Arca tortuosa. do. do.
66. Pectunculus glycimeris. do. do.
67. Nucula rostrata.
68. Trigonia pectinata. exterior of one valve. *a.* interior of right valve. *b.* ditto of left.

Plate 2. Vol. 15.

Fig.
69. Unio sinuata. exterior and interior.
70. Hyria avicularis. do. do.
71. Anodonta cygnea. do. do.
72. Iridina ovata.
73. Diceras arietinum.
74. Chama lazarus. exterior of one valve. *a. b.* interior of each valve.
75. Etheria elliptica. exterior and interior.
76. Tridacna gigas. back view of the valves united, shewing the open lunula. *a. b.* exterior and interior.
77. Hippopus maculatus. back view, shewing the close lunula. *a. b.* exterior and interior.
78. Modiola papuana. exterior and interior.
79. Mytilus Magellanicus. do. do.
80. Pinna rudis. do. do.
81. Crenatula modiolaris. do. do.
82. Perna ephippium. do. do.
83. Malleus albus. do. do.
84. Avicula crocea. do. do.

PLATE 3. VOL. 15.

Fig.
85. Meleagrina margaritifera. exterior and interior
86. Pedum spondyloideum. do. do.
87. Lima squamosa. do. do.
88. Plagiostoma transversa.
89. Pecten maximus. exterior and interior.
90. Plicatula cristata. do. do.
91. Spondylus gæderopus. exterior of one valve. *a. b.* interior of right and left valve.
92. Podopsis truncata. exterior and interior. (*Encyclopedie.* Pl. 188. Figs. 6 and 7.)
93. Gryphæa angulata.
93*. Gryphæa cymbium.
94. Ostrea edulis. exterior and interior.
95. Vulsella spongiarum. do. do.
96. Placuna sella. exterior of one valve. *a.* interior of lower valve. *b.* ditto upper.
97. Anomia ephippium. lower valve. *a.* interior of ditto. *b.* interior of upper valve.
98. Sphærulites foliacea. (*Encyclopedie.* Pl. 172. Fig. 7.)
99. Radiolites rotularis.
100. Calceola sandalina.
101. Briostrites inæquilobus. (*Sowerby's Gen. of R. and F. Shells.*)
102. Crania personata. exterior of upper valve. *a.* interior of ditto. *b.* interior of lower valve.
103. Orbicula Norvegica. exterior and interior.
104. Terebratula vitrea. front view of the valves united. *a.* interior of larger valve. *b.* interior of smaller ditto, shewing the ramified processes for the support of the animal.
105. Lingula anatina. exterior and interior.

PLATE 7. VOL. 15.

Fig.
106. Hyalæa tridentata.
107. Balantium recurvum.
108. Cleodora pyramidata. (*Ann. du. Mus.* 15. Pl. 2. No. 14.)
109. Cymbulia Peronii. (*Ann. du. Mus.* 15. Pl. 3. No. .)
110. Chitonellus lævis.
111. Chiton squamosus.
112. Patella granatina.
113. Pleurobranchus Peronii. (*Ann. du Mus.* Tom. 5. Pl. 18. Fig. 5.)
114. Umbrella Indica. *a.* under side of the shell.
115. Parmophorus Australis.
116. Emarginula fissura.
117. Fissurella nimbosa.
118. Pileopsis ungarica.
119. Calyptræa equestris. *a.* under side.
120. Crepidula fornicata. *a.* under side.
121. Ancylus lacustris.
122. Bullœa aperta.
123. Bulla lignaria.
124. Laplysia depilans.
125. Dolabella Rumphii *a.* concave side.
126. Parmacella calieulata. under and upper side.
127. Limax rufus.
128. Testacella haliotidea. *a.* under side.
129. Vitrina pellucida. upper and under side.
130. Helix gigantea.
131. Carocolla accutissima.
132. Anastoma depressum.
133. Helicina neritella.
134. Pupa mumia.
135. Clausilia torticollis: the small figures below represent the two valves of the penultimate whorl.
136. Bulimus hæmastomus.
137. Achatina perdix.
138. Succinea amphibea.
139. Auricula Midæ.
140. Cyclostoma volvulus.
141. Planorbis corneus.
142. Physa fontinalis.
143. Lymnœa stagnalis.
144. Melania truncata.
145. Melanopsis lævigata.
146. Pirena terebralis.
147. Valvata piscinalis.
148. Paludina vivipara.
149. Ampullaria Guyanensis.

PLATE 8. VOL. 15.

Fig.
150. Navicella tessellata. *a.* under side.
151. Neritina pulligera.
152. Nerita exuvia.
153. Natica glaucina.
154. Ianthina communis.
155. Sigaretus haliotideus. under and upper side.
156. Stomatella sulcifera. do. do.
157. Stomatia phymotis.
158. Haliotis Iris.
159. Tornatella flammea.
160. Pyramidella dolabrata.
161. Vermetus lumbricalis.
162. Scalaria pretiosa.
163 Delphinula laciniata.
164. Solarium perspectivum.

Fig.
165. Rotella lineolata.
166. Trochus imperialis. *a.* under side.
167. Monodonta pagodus.
168. Turbo marmoratus.
169. Planaxis sulcatus.
170. Phasianella bulimoides.
171. Turritella duplicata.
172. Rissoa.
173. Cerithium palustre.
174. Pleurotoma Babylonia.
175. Turbinella cornigera.
176. Cancellaria reticulata.
177. Fasciolaria tulipa.
178. Fusus colus.
179. Pyrula caliculata.

PLATE 5. VOL. 16.

Fig.
180. Struthiolaria nodulosa.
181. Ranella gigantea.
182. Murex brandaris.
183. Triton variegatus.
184. Rostellaria curvirostris.
185. Pterocera lambis.
186. Strombus latissimus.
187. Cassidaria echinophora.
188. Cassis glauca.
189. Ricinula horrida.
190. Purpura persica.
191. Monoceros imbricatum.
192. Concholepas Peruvianus.
193. Harpa ventricosa.
194. Doluim perdix.

Fig.
195. Buccinum undatum.
196. Eberna glabrata.
197. Terebra maculata.
198. Colombella mercatoria.
199. Mitra episcopalis.
200. Voluta diadema.
201. Marginella glabella.
202. Volvaria bulloides.
203. Ovula oviformis.
204. Cypræa cervina.
205. Terebellum subulatum.
206. Ancillaria cinnamomea.
207. Oliva porphyria.
208. Conus marmoreus.

PLATE 6. VOL. 16.

Fig.
8**. Vermilia rostrata. *a.* the beak of the aperture.
8***. Galeolaria decumbens. natural size. *a.* operculum — very much magnified. *b.* aperture ditto. (*Sowerby's Gen. of R. and F. Shells,* No. 11.)
12*. Creusia spinulosa. *a.* operculum.
68*. Castalia ambigua, exterior of one valve. *a. b.* interior of both valves.
108*. Limacina helicialis, upper and under side.
131*. Carocolla acutissima.
169*. Planaxis sulcatus.

Fig.
209. Belemnites subconica. (*Trans. R. S. E.* Pl. 25. Fig. 3.)
209*. ———— mamillata.
210. Orthocera raphanus. *a.* nat. size. (*Ency.* Pl. 465. Fig. 2. *c.*)
211. Nodosaria radicula. *a.* nat. size. (*Ency.* Pl. 465, Fig. 4. *b.*)
212. Hippurites rugosa. *a.* larger end.
213. Conilites. pyramadata, (*Sowerby's Min. Con.* No. 46. Pl. 260. Fig. 3.)
214. Spirula Peronii.
215. Spirolinitis cylindracea. (*Ency.* Pl. 466. Fig. 2.)
216. Lituolites nautiloidea. (*Ency* Pl. 465. Fig. 6.)

Fig.
217. Renulites opercularis. (*Ency.* Pl. 465. Fig. 8.)
218. Cristellaria squammula. *a.* nat. size. (*Fichtel.* Pl. 16. *b.*)
219. Orbiculina numismalis. *a.* nat. size. *b.* transverse section, shewing the chambers. *c.* side view, shewing the aperture. (*Fichtel.* Pl. 21. *a. b. c. d.*)
220. Miliolites coranguinum. (*Ency.* Pl. 469. Fig. 2. *a. b.*)
221. Melonites sphærica. *a.* nat. size. *Fichtel.* Pl. 24. *b.*)
222. Rotalites trochidiformis. upper and under side.
223. Lenticulites rotulata. (*Ency.* Pl. 466. Fig. 5.)
224. Placentula pulvinata. *a.* nat. size. (*Fichtel.* Pl. 3. *b.*)
225. Discorbites vesicularis. (*Ency.* 466. Fig. 7. *a.*)
226. Siderolites calcitrapoides. *a* nat. size. *b.* transverse section. (*Fichtel.* Pl. 15. *e. k.*)
227. Polystomella crispa. *a.* nat. size. *b.* side view. *c.* transverse section. (*Fichtel.* Pl. 4. *d. e. f.* and Pl. 5. *b.*)

Fig.
228. Vorticialis craticulata. *a.* nat. size. *b.* side view. (*Fichtel.* Pl. 5. *h. i. k.*)
229. Nummulites lævigata.
230. Nautilus pompilius.
231. Ammonites Königi. (*Sowerby's Min. Con.* No. 46. Pl. 263. Fig. 3.)
232. Orbulites subradiata.
233. Ammonoceratites glossoidea. (*Bowdich.* Pl. 3. Fig. 14.)
234. Turrilites costulata. (*Sowerby's Min. Con.* Pl. 36.)
235. Baculites Faujasii.
236. Argonauta Argo.
237. Loligo vulgaris—the corneous lamina very much reduced. *a. b.* cranium—nat. size. *c.* the beaks united. *d. e.* its parts separate—*f.* indented ring of the sucker.
238. Sepia officinalis, the shell very much reduced. *a.* beak. *b.* sucker ring. *c.* egg. All nearly the natural size.
239. Carinaria vitrea. (*Ency.* Pl. 461. Fig. 3.)

ERRATA.

Vol. xv. p. 219, line 26, for "*air-holes*," read "*suckers*."
Vol. xv. p. 248, line 8, for "*nerita*," read "*natica*."

Art. VII. *Experiments on the Proportion of Charcoal obtained from Woods having a greater Specific Gravity than Box.* By Mr. T. Griffiths.

The pieces of wood, having their respective weights carefully taken, were put into crucibles covered with sand, which were placed in a strong heat, till all the volatile products were dissipated. The charcoal thus obtained was weighed whilst warm, in order to prevent any inaccuracy that might have been occasioned by the absorption of moisture from the air. Of the many different woods that might have been employed, eight specimens have been selected, and the result of the experiments made upon them, are

detailed in the following tables; the first of which shews the specific gravity of the different woods. The second table shews the proportion of charcoal in one hundred parts of the respective woods.

In the third table the specific gravity of the charcoal is taken in the following manner. Its weight was taken in air, with its surface slightly varnished, which, when it was weighed in water, prevented that fluid from filling its pores. But this method not giving the true specific gravity of the charcoal as its pores were filled with air, another was adopted, in which the charcoal having been weighed in air was put at the botton of a glass of water under an exhausted receiver where it remained several hours till the air it contained was expelled. Upon removing the receiver the charcoal was saturated with water by the pressure of the atmosphere upon its surface. In this state it was weighed in water; the specific gravities obtained by this method are given in the fourth table.

In regard to electrical conducting power, charcoal from satin wood is the best, and charcoal from tulip wood the worst. The other specimens discharge a battery with nearly equal energy.

TABLE 1.

Lignum Vitæ	1.342
Cocoas wood	1.336
Ebony	1.226
Brazil wood	1.132
Satin wood	1.078
Tulip wood	1.070
King wood	1.069
Botany Bay wood	1.067

TABLE 2.

Ebony	30.5
Botany Bay wood	28.1
Brazil wood	26
Cocoas wood	22.5
King wood	22
Tulip wood	20.8
Satin wood	20.7
Lignum Vitæ	17.5

TABLE 3.

Lignum Vitæ	0.94
Ebony	0.93
Cocoas wood	0.86
Tulip wood	0.76
Botany Bay wood	0.57
Satin wood	0.55
King wood	0.7
Brazil wood	0.6

TABLE 4.

Lignum Vitæ	1.84
Cocoas wood	1.36
Satin wood	1.26
Tulip wood	1.17
Botany Bay wood	1.12
King wood	1.04
Ebony	1.4
Brazil wood	0.84

Art. VIII. *Description of* Mr. Rider's *Rotatory Steam-Engine. (With a Plate.)*

[To the Editor of the Quarterly Journal of Science.]

Belfast, August 27, 1823.

Sir,

A variety of occurrences have, until now, induced me to decline publishing on the subject of my rotatory steam-engines. My principal reason was, that I did not wish to appear before the public until the matter, from actual experience, and deliberate trial, was placed beyond a doubt of success. I feel the greater satisfaction in informing you that I consider this desirable object is now attained, there being three engines on my principle at present working at different places in this neighbourhood with the greatest success, one of which is twelve, one sixteen, and the other twenty horse power.

I send you herewith drawings, and a description of my rotatory engine, through my friend Mr. Boyd; and should you still entertain the same favourable opinion of the improvement, which you were pleased to express to him, I shall feel much obliged by your taking such notice of it as you think it deserves, in the Journal which you conduct.

The advantages which these engines possess, are, that they require less room, less weight, consume less fuel, and are cheaper than the common engine; beside the expense of foundation work, and buildings necessary for erection, is considerably reduced.

By this important improvement, so long sought after, the operation of the steam on the piston, from its first action, is completely uniform, and may be communicated to any purpose required, without the loss of power occasioned by the use of lever beams, crosses, cranks, fly wheels, or balances of any description.

For steam navigation these engines are peculiarly adapted, where the saving of room and weight is an object of much importance.

Should you think any farther information than what is now communicated necessary, I shall feel great pleasure in affording it.

I am, Sir,

Your most obedient servant,

J. RIDER.

Description of a Patent Rotatory Steam-Engine, manufactured by Job Rider and Co., *Belfast.*

Plate IX. The two figures show the parts of a twenty-horse engine, the same marks of reference are used to denote the same parts in both. Fig. 1, is a section cut through the centre at right angles to the axis. Fig. 2, is a middle section cut through the centre of the axis.

Fig. 1 and 2, the fixed parts are *aaaa*; the outside cylinder has a flanch *bb* near each end, and two internal eccentrics *cc*; on the outside of it are two flanched branches ⟶, one of which connects the engine with the boiler, the other with the condenser. It is covered with two ends, *eeee*, (as shewn in Fig. 2,) each end having a centre flanched branch, into which is fitted a flanched socket DD, screwed down on hemp packing, shewn by dotted shade.

The revolving parts are 1, 1, the inside cylinder (which is fixed on the axis 2.2.2.2.) has six cavities, or interstices, *d.d.d.*, into which are fitted sliding valves 3.3.3.3.; upon each end of it are fitted flanches (Fig. 2,) 5.5.5.5. shewn by the sloping lines; these flanches are screwed together through the arms of the cylinder, as shewn by 6.6.6.6. (Fig. 1,) each flanch having grooves proceeding to its extremity, equal in depth to the rabbet of the flanches upon the cylinder, and coresponding with the valve recess *dd*, in the inside cylinder 2.2.2. The sliding valves are made to work steam tight in these grooves; they are connected by ground steel pins, which pass through the axis, as shewn in Fig. 2, by 4.4.4.4. These pins keep the edges of the sliding valves close to the (fixed) outside cylinder, both in its eccentric and concentric parts (as shewn Fig. 1,) during the time that the inside cylinder, with its flanches and sliding valves, are turned upon their axis.

The sliding valves are at their full extent when passing the

lower concentric part of the outside cylinder, at which place the power is obtained, and they are close in the recesses of the inside cylinder when passing the upper concentric part.

Fig. 1, *r.r.r.r.* is an oblong flanched box, which has a cover screwed to its flanch; through the cover are screws with guard rivets XD, which press down the hemp packing *k*, by means of the plate 1, keeping the piece of brass *o* close to the inside cylinder 2.2.2.2.

The ends of the piece of brass *o* come close to the inside of the revolving flanches, and a packing is completely formed between the outside of the upper concentric part (in the eccentric CC.) and the inside of the revolving flanches *5.5.5.5.*

Fig. 2, *yy*, are sections of rings kept close to the outside of the revolving flanches 5.5.5.5. by spiral springs placed in the thick part of the cover *eeee*.

The engine is placed between the boiler and condenser, the boiler producing, and the condenser destroying, steam. It has on the boiler-side a pressure of steam, and on the condenser-side nearly a vacuum, the steam-gauge standing at six inches of mercury more than the pressure of the atmosphere, and the vacuum-gauge standing at 26 inches less. This gives a power of 16 pounds on the square-inch.

The course of the steam gives a velocity of 600 feet per minute of a revolving motion, to the extremity of the sliding valves, and forces round the inside cylinder 2.2.2.2. and the shaft 1. Fig. 1. ⟶ ⟶ show the course of the steam from the boiler to the condenser, according as the engine is connected to them.

The engine can be made so that the motion may be reversed at pleasure. The air-pump and under work belonging to the engine, which are not shewn in the plate, may be made on the common construction.

[To the Editor of the QUARTERLY JOURNAL OF SCIENCE.]

Fort Breda, 27th August, 1823.

SIR,

In addition to Mr. Rider's letter explanatory of the advantages

his engines possess over the common ones, I have only to add, that like many others not professionally occupied with the science of mechanics, I had my doubts as to the superiority of his invention; and it was not until I had the experience of ocular demonstration, confirmed by the judgment of people versed in steam-engines, that my prejudices were removed; but having witnessed the engines he mentions in his letter to you, at work, and hearing the favourable report of all parties, I now confess myself a complete convert. The chief objections urged against these engines, is the fear of greater wear than in others. Now this has been quite satisfactorily proved to be even less. The engine at Messrs. Grimshaw's, (a twelve-horse power,) after working all last summer, and driving all the machinery of the printfield, day and night, (for there was no supply of water to drive the wheel,) was taken asunder, and the sliding valves and water cylinder examined, when no apparent wear or tear was visible, although during the entire *period it had never been fresh packed.* This was the first engine made of the kind, except the model one at the foundry. It was warranted equal in power and durability to an engine of twelve-horse power on the old construction, and the time of payment left to Messrs. Grimshaw's discretion. They are now so well satisfied that they have paid for it, and so they well might, as it does not require more than half the fuel necessary for one of the best engines on the old principle! The sixteen-horse engine to which Mr. Rider alludes, is at Messrs. Bell's Bleach-works, Ballyclare, where it affords the greatest satisfaction. The twenty-horse engine is at Messrs. Alexander's flour-mills. It drives three pair of mill stones with a full feed of grain, and could readily drive a fourth pair, did the connecting machinery answer, with a pressure of from four to six inches on the mercurial gauge. In fact, the real power of these engines is yet unknown, and the multifarious advantages attending them are such as to demand the serious attention of all manufacturers, and others who have machinery to drive.

I am sure you will feel great pleasure in giving publicity to this invention through your widely circulated Journal, it being one of the greatest importance to the arts and manufactures; and which,

in my humble opinion, bids fair to constitute one of the greatest improvements yet made in the steam-engine.

I had almost forgotten to mention a circumstance which has, doubtless, operated against the good name of this invention in Glasgow, *i. e.*, the bad success attending the engine put on board the Highland-lad steam-vessel, by Messrs. Girdwood and Co., through Mr. R.'s license. In consequence of the evil reports (which were *industriously circulated,*) Mr. R. and I went to Glasgow, where, on inspection, we found the engine differed most materially from his plan, and was extremely defective indeed, so much so, that it is wonderful it had any power whatever. By way, however, of letting the good folk on the other side of the water witness the astonishing effect of his improvement, he is now engaged in constructing an engine to be mounted in a boat at Glasgow, where all may have an opportunity of judging for themselves.

I have the honour to be,

Sir,

Your most obedient servant,

WILLIAM BOYD.

Art. IX. *Observations on the Modern Theory of Physical Astronomy. By* John Walsh, Esq.

[Communicated by the Author.]

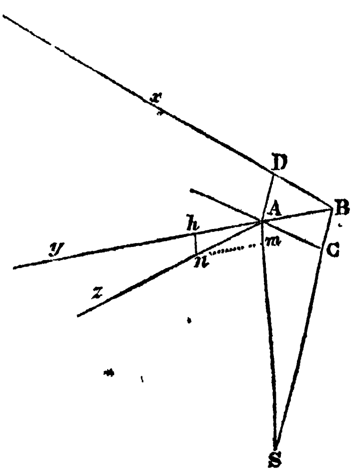
Men, in general, are too apt to form theories without thoroughly examining the bases on which they found them, and the consequences that may follow from them; and, as well as others, the geometer and the natural philosopher have often committed themselves in this way. When the geometer departs from the spirit of demonstration, he is no longer to be depended upon. Sometimes I meet, even in the works of the most illustrious mathematicians, with the expression, "rigorous demonstration." This sounds oddly, I cannot perceive the necessity of the word rigorous, or of any adjunct of similar meaning, as applyed to demonstration. Both sides of an equation, being only different manners of repre-

senting the same magnitude, or the same relation, whatever change takes place in one side, must take place also in the other. If this is not the case, it is a proof that no equality exists. The force of gravity, if such a force exists, is said to vary inversely as the square of the distance from the attracting body. Let F be this force, at any distance R, and f any other force of the same attracting body, at any other distance r, then,

$$\frac{F}{f} = \frac{r^2}{R^2}$$

If we make R nothing, then the force F is infinitely greater than the force f, whatever may be r, which is absurd. Then, therefore, no equality can in every case exist, between the two sides of this equation. Therefore, the law of universal gravity, or rather what is said to be this law, is not the true law.

It appears to me that the first law of Kepler, if this law is true, is not yet demonstrated to be true.



Let any body be at rest at B, and let it be acted on at the same instant by two forces, represented by, and in the direction of, the straight lines B C, B D; by the joint effect of these forces, it will move with a uniform motion along the diagonal B A. Now, at the instant it is arrived at A, let the central force S act again on it, and cause it to move along the line A z. It is required to determine, how shall this second central force be represented. This is always done by taking A h = A B, and drawing $h\,n$ parallel to A m, and $n\,m$ to h A; then, A m is said to represent this force; now, if this is true, then no force whatever acting in the direction A S, on the body when at A, could cause it to move along this line A S, which is absurd, as the body was not at rest, when at A. Then, there-

fore, A m cannot represent the second impulse of the central force. Then, therefore, the first law of Kepler, if true, is not yet demonstrated to be true.

Let us now try if any other law, more conformable to the nature of analysis, and the spirit of demonstration, can be substituted in the place of the inverse ratio of the square of the distance, to show the variations of the force with which any two attracting points act on each other, when at any distance asunder.

When the points are in contact, the spaces which they would uniformly describe in the same time by their total actions on each other, were they free to move, would be inversely as their forces. Let C be the straight line, which any of them may uniformly describe in any given time, by an action equal to that, which the other point would exercise on it when in contact with it; and let x be the distance of this point from the point of contact, which I call the centre of gravity of the two attracting points; then, $\frac{c^3}{(c+x)^2}$ will always represent the force whatever may be x. And no other can be the law of universal gravity, if such a principle exists. Let a and y correspond to the second attracting point, then we shall have for the relation between the forces with which they act on each other, $\frac{c^3(a+y)^2}{a^3(c+x)^2}$ a constant quantity, whatever may be x and y.

John Walsh.

Art. X. *Description of a Grotto in the Interior of the Colony of the Cape of Good Hope. By* Mr. G. Thompson.

[Communicated by the Rev. F. Fallows.]

The Grotto is situated in the Kango, in the district of George, about 360 miles from Cape Town. It was first discovered by a Mr. Botha, a farmer, by accident, when on a hunting party, and a few days afterwards it was entered by him and a party of farmers; this occurred in the year 1780.

The hill, where the grotto is, is between 5 and 600 feet in

height, being part of an extensive chain of calcareous mountains which divides the Kango country from the great Kaaroo or desert. The entrance is at the height of about 100 feet from the level of a brook which passes close to the hill. The door-way or entrance is about 20 feet high, and a most romantic excavation. From the entrance you are led in nearly a horizontal direction for 200 feet, when a precipice of 33 feet presents itself, and which is descended by a ladder into *Van Zeily's Hall*, (named after the discoverer, as are likewise the other chambers,) a most wonderful subterranean vault about 100 feet broad, varying in height from 60 to 70 feet, and measuring in length about 600 feet. The scenery in this cavern is grand and awful in the extreme, adorned with the most splendid stalactites, which were greatly beautified by the glare of torches, some of the columns rising to the height of 40 feet, (caused by a single drop of water from the roof,) others appearing in the shape of cauliflowers, festoons, and assuming all kinds of fantastic forms. The next apartment is the Registry (from the names being wrote upon the walls) about 40 feet broad, and 25 feet high. From this we are led to Botha's Hall, about 140 feet broad and 50 feet high; adjoining this is the south chamber, a small place about 30 feet long, 15 broad, and 20 high, which leads to Vander-West-huissen's Chamber, 15 feet high, 10 long, and as many broad; from this we are led to Thom's Chamber, 14 feet long, 8 broad, and 15 high. At the end of this last mentioned apartment a precipice of 14 feet, prevented others exploring this grand cavern, however I ventured down, followed by three slaves, who all lost their torches in the descent, and fell neck over heels; fortunately my light was secured, when I proceeded first into what I take upon myself to call "George Thompson's Chamber." This I fully explored, and found it about 500 feet long, 50 broad in some parts, and varying in height from 20 to 40 feet. This is the extremity of the cavern, which I presume may be upwards of 1500 feet from the entrance. On the right, near the ladder, is Bat Corner, or Fledermuishoek. The Rhombus is on the right of Van Zeily's Hall. The Pyp or Yzigle Chamber, and the Bath-house are also on the right of Botha's Hall. The passage between

the South Chamber and Vander-West-huissen's Chamber is so narrow as scarcely to admit a large person, and is called Botha's Poort or door, likewise Nel's Poort, is equally narrow between Vander-West-huissen's and Thom's Chamber. These apartments constitute the whole of this very extensive series of subterraneous caverns; and should there be any other apartments, they must communicate by a very small passage, as I narrowly examined every part. The beauty of some of the chambers cannot be described. The production of the stalactites is very surprising; a single drop of water from the roof, in time will raise a column 50 feet high. A great many drops have produced cauliflowers, pulpits, and other beautiful and romantic festoons, shewing the remarkable action of water, and carbonic acid upon calcareous rock. The Bath-house contains several basins of clear water. Innumerable quantities of bats have taken up their residence here, (apparently from the excrement,) from time immemorial—they are the only inhabitants of these lonely regions. The heat is great, and even oppressive at the farthest extremity. Had this beautiful grotto been situated where it was more accessible to mankind, and not so far in the wilds of a desert country, we should ere this time have seen a proper account of it, by which means it would have been plucked from the obscurity which shrouds it at present, and have gratified the eyes of the curious, and the lovers of the sublime.

Art. XI. *On some undescribed Minerals. By* H. J. A. Brooke, Esq., F.R.S.

Childrenite.

About four years since I purchased at Tavistock, in Devonshire, three specimens of a mineral, said to have been taken from some part of the ground which had been perforated for the canal lately completed there. They were supposed to be carbonate of iron, but it was obvious on looking at the crystals that they must belong to some other substance.

Intervening occupations prevented me for a long time from ex-

amining them, but it is now several months since I ascertained from the measurement of their angles that they differed from the crystals of every other known mineral. They are so very minute, that the whole quantity I possess would weigh only a few grains. A part of one of the specimens, however, enabled Dr. Wollaston to ascertain that the mineral was a *Phosphate of Alumina and Iron.*

The attention which Mr. Children has shewn to mineralogical chemistry, is one, among many other inducements to name this mineral *Childrenite.*

The form of the crystals is represented by the accompanying figure, except in this particular, that the planes marked *b*, in the figure, generally consist of a number of very narrow planes with parallel edges, but whose inclinations upon *e*, I have not been able to measure.

P on *e* or *e''*	.	114° 50′
P on *a*	. . .	152 10
P on *f*	. . .	90
e on *e′*	. . .	130 20

I have not succeeded in cleaving the crystals, but we may assume *a right rhombic prism* as their *primary form;* and if we suppose the planes *e* to be produced by decrements upon its terminal edges, the lines between *e e′*, and *e″ e‴*, would obviously lie on the lateral primary planes, and the inclination of these planes would then be 92° 48′.

If the planes *e* result from a decrement, by one row of molecules, the terminal edge would be to a lateral edge, nearly as 13 to 28, and the planes *a* might then be represented by the symbol $\overset{6}{A}$.

The crystals slightly scratch glass. Their colour is wine yellow. And in the only specimens I have seen they occur on the surface of crystallized quartz, and might be mistaken by a casual observer for sulphate of barytes.

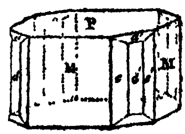
Somervillite.

The next mineral I shall have to describe came to me with some

other Vesuvian substances, from Dr. Somerville, from which circumstance I have named it *Somervillite*.

Its *primary form* is *a right square prism*, but the crystals are modified on the solid angles and lateral edges, as in the annexed figure.

P on *a*	. .	147°	5′
P on M	. .	90	
M on *e*	. .	161	33
M on *d*	. .	135	
M on M′	. .	90	



Assuming the planes *a* to result from a decrement by one row of molecules, the terminal edge of the *primary form* would be to the lateral edge, as 16 to 25 nearly. The planes *e* result from a decrement by three rows in breadth on the lateral edges.

The crystals may be cleaved easily parallel to the terminal planes, but imperfectly, if at all, parallel to the lateral planes or to the diagonals of the prism. Their colour is a very pale dull yellow.

The substance for which this might at first view be mistaken is the *idocrase*, although no plane corresponding in its inclination on P with the plane *a* of the preceding figure, has yet been observed on any crystal of that substance. But these crystals are much softer than *idocrase*, the cleavage parallel to the terminal planes much more distinct, and the cross fracture more glassy.

They occur in cavities, with crystallized black mica, and with another substance which I have not yet examined; and the mass to which they adhere appears to be nearly all *Somervillite*, intermingled with black mica.

Mr. Children has taken the trouble to compare the characters of this mineral under the blow-pipe, with those of *idocrase*.

When exposed alone in the forceps it slightly decrepitates, which *idocrase* does not, and fuses, with greater difficulty than idocrase, into a greyish glass, the globule from *idocrase* being greenish. With borax, in the reducing flame, *idocrase* produces a light green, and this a colourless glass.

Kupferschaum.

I do not find any analysis published of the mineral termed *Kupferschaum* by the Germans, which is the same as the fibrous or flaky bright green substance found at Matlock.

It dissolves entirely and with effervescence in muriatic acid. From this solution a bulky precipitate is thrown down by caustic potash, a considerable part of which is redissolved by an excess of the alkali, leaving a residuum of *hydrate of copper*. If the solution be filtered to separate the copper, and acetous acid be added, a white flocculent precipitate appears, which may be redissolved by an excess of acid or of alkali. As this is a marked character of oxide of zinc, I conclude that the mineral is a *carbonate of copper and zinc*.

ART. XII. *On a Mountain Barometer constructed with an Iron Cistern. By* J. Newman, *Philosophical Instrument-Maker to the Royal Institution of Great Britain.*

[To the Editor of the Quarterly Journal.]

SIR,

I TAKE the liberty of sending you an account of an alteration I have made in the construction of Mountain Barometers, and which has been declared highly satisfactory and important, by those who have made trial of instruments so constructed. The object has been to correct those defects and errors which arise from the use of a wooden cistern and leather bag, in the common instrument. It has been found that when the cistern is made of a wood sufficiently sound and close-grained to permit of the pressure required from the screw to make the instrument portable, that it is so impervious to air, as not to allow it to pass with sufficient freedom, and consequently, that when the instrument is used at any great altitude, the mercury cannot fall into the cistern except with considerable difficulty, and a long time is required before an accurate observation of the air's pressure can be made; most generally, however, the cistern is sufficiently pervious to air, but it is then found that on

screwing up the mercury to the top of the tube, a portion of the metal generally makes its way through the wood, thus soon rendering the instrument quite useless; for it is very evident that a barometer that loses a portion of mercury from the cistern by making it portable or otherwise after it is adjusted, can no longer be correct or give the height of the column.

To obviate these inconveniences, I have substituted a cistern of iron in place of the wooden one; it is fastened to the tube by a thick collar of wood, which is glued on in the usual manner; a screw passes through the centre of the bottom, so as to move in a line with the barometer tube; it is terminated inside the cistern by a piece of cork tied over with leather, so that the instrument being inclined that the tube may be filled with mercury, this cork may be screwed up against the end of the tube, and effectually preserve the metal within from oscillation, without subjecting the cistern itself to any pressure.

As there is no pressure on the mercury in the cistern, the wooden cap may be left so porous in one part, as to allow of the ready access of air, so that the column shall fall freely to its proper level, without any danger of losing mercury.

Another great object in a mountain barometer, is to obtain the temperature of the mercury, which is done by fixing a thermometer with the bulb in the cistern; I have found that by carrying a barometer in my hand and near the body, the temperature is increased considerably, and will frequently rise as high as 85° F.

In the barometer of common construction, the height of the column of mercury is marked off from another instrument, presumed as a standard, and in that case, the actual height is rarely or ever given, for every change that takes place in the weight of the atmosphere, alters barometers more or less according to the proportion which the diameters of the tubes bear to those of the cisterns, and for that reason, upon examining twenty barometers no two will agree, unless they were marked off together, and happen to stand at that exact height.

To remedy this source of error each instrument may be reckoned a standard, the height of the column is marked off from the sur-

face of the mercury, and the point given at which it was marked off; when with the correction for the capacities of the tube and cistern, and also the temperature, the actual height of the barometer is ascertained. Upon examining the first four which I made independent of each other on this principle, one for Mr. Daniell, one for the Royal Society, and two for Captain Sabine, they agreed within .004 of an inch with each other.

Art. XIII. *Observations on the Ultimate Analysis of certain Vegetable Salifiable Bases.* By W. T. Brande, Esq., Sec. R.S., and Professor of Chemistry in the Royal Institution.

Since the discovery of a peculiar crystallizable substance, possessed of alkaline properties, in opium, by M. Sertuerner, in the year 1816, a variety of analogous salifiable bases have been detected in, and separated from, other vegetable products. Among these none are more remarkable than the two substances discovered in certain species of the genus *Cinchona* by Messrs. Pelletier and Caventou, in the year 1818. To that separable from the common pale Peruvian bark, (Cinchona Lancifolia,) they have given the name of *Cinchonin;* and of *Quinine*, to that obtained from the yellow bark, (Cinchona Cordifolia.) They have also ascertained that the red bark contains no distinct principle, but that it derives its virtues from a mixture of those existing in the two varieties just named. In conformity with the principles of chemical nomenclature adopted in this country, the former may be called *Cinchonia* and the latter *Quinia*.

The essential medical virtues of opium, cinchona, and of the other substances in which they have been found, appear, in all cases, to depend upon these newly-discovered bodies, and in this respect they promise to form very important articles in the *Materia Medica;* and they are particularly interesting to the chemist, as constituting a distinct class of salifiable bases, possessed of

some of the properties of alkaline bodies, and presenting a curious contrast in their ultimate composition, to the vegetable acids especially, and to the proximate products of the vegetable kingdom in general.

In examining morphia, very soon after its discovery, I was much struck with the peculiar products which it appeared to afford when submitted to ultimate decomposition; I did not, however, at that time pursue the subject, conceiving that it would form a part of the inquiries of its discoverer. But I have since recognised the same peculiarities in cinchonia and quinia, and the views of their nature, to which my experiments have led me, are very different from those of Messrs. Pelletier and Caventou*, and appear important in respect to the ultimate composition of vegetable bodies in general.

These substances agree in being difficultly soluble in water, in alcohol, and in ether, at common temperatures, but they dissolve in considerable proportion in boiling alcohol, which deposits them as it cools. Morphia, cinchonia, and strychnia, are thus obtained in the crystalline form; quinia is uncrystallizable, and separates as the alcohol cools, in the form of a viscid mass, somewhat resembling birdlime. They are tasteless, or only slightly bitter, in their pure and dry state, but the addition of the smallest portion of acid gives rise to intensely bitter compounds. When exposed to a moderate heat they exhibit no signs of water of crystallization, but at higher temperatures they fuse like resins, and concrete on cooling, with the exception of quinia, into a radiated crystallized mass. At a temperature of 300°, cinchonia decrepitates, and at 450° it fuses, becomes brown, and a portion sublimes and condenses on cooling in brilliant acicular crystals which resemble the original substance.

At a red heat these substances are all decomposed with nearly similar phenomena, and the results are remarkable as presented by a vegetable body. Under these circumstances they produce great abundance of ammonia, which is easily recognised by its

* *Annales de Chimie et Physique*, XV.

smell and action upon turmeric paper; the odour of prussic acid may also be distinctly perceived; an oily matter smelling like naphtha, distils into the cool part of the tube in which the experiment is made, and a very abundant carbonaceous residue remains.

The most remarkable circumstance attending this decomposition of cinchonia, is the entire absence of all appearance of aqueous vapour, of which I have never been able to distinguish any traces, provided care had been taken to exclude air, even when the products were made to pass through a considerable extent of cooled tube. This led me to suspect the entire absence of oxygen in this substance, an opinion which was corroborated by its total want of action upon potassium, when heated with that metal in naphtha: the cinchonia, under these circumstances, readily dissolves in boiling naphtha, and again entirely separates as the solution cools, concreting into a radiated crystallized mass, in which the brilliant globules of potassium are disseminated.

The singular and characteristic properties of these vegetable alkalies, induced me to pay more attention to their ultimate analysis, and to endeavour to attain more accurate information respecting the nature and proportions of their elements, especially as cinchonia is stated, by its discoverers, to consist of oxygen, hydrogen, and carbon, and to be deficient in nitrogen *; a statement at which I am the more surprised, since a repetition of their principal experiments upon these bodies, has convinced me of the extreme accuracy of their difficult researches. In these experiments, which are always tedious and difficult, I have availed myself of the forms of apparatus contrived by Dr. Prout and Mr. Cooper, (*Henry's Elements*, ii. 165,) employing the peroxide of copper as originally recommended by M. Gay-Lussac, (*Ann. de Chimie*, xcvi. 53,) with the precautions suggested by Dr. Ure, in his valuable paper on the ultimate analysis of organic substances published in the *Philosophical Transactions* for 1822.

* *Annales de Chimie et Physique*, *XV*. 296.

From an experiment made with Dr. Prout's apparatus the relative proportions of carbon, nitrogen, and hydrogen, in cinchonia were estimated as follows:

Carbon	80.20
Nitrogen	12.85
Hydrogen	6.85
	99.90

In this analysis the permanently gaseous products were collected at one operation, and the hydrogen was estimated by a second experiment in which every product was allowed to escape from the tube, and the weight of carbonic acid and nitrogen then deducted from the entire loss.

In a second experiment, in which Mr. Cooper's apparatus was employed and in which, as in the others, he was good enough to assist me, similar proportions of cinchonia and of oxide of copper, were employed, but the water produced was retained in a portion of the tube, cooled for the purpose, and its quantity ascertained afterwards, by carefully weighing the tube, first in its original state, and a second time after the entire expulsion of the water by heat. The following is the result of this experiment:

Carbon	78.4
Nitrogen	14.6
Hydrogen	7.5
	100.5

Several other experiments were made chiefly with a view of detecting the presence of oxygen, but that element was in no instance discovered, either by any loss of weight, as indicated by the results of destructive distillation, or indirectly, by the appearance of aqueous vapour in other processes of decomposition. Among the latter, the effect of chlorine upon cinchonia may perhaps be regarded as most satisfactory. Five grains of carefully dried cinchonia, were introduced into a small exhausted retort which was afterwards filled with chlorine. There was no absorption of the gas, nor the smallest apparent action until very consider-

able heat was applied; the substance then blackened and was evidently decomposed, and upon examining the retort when cool, it was found to contain muriatic acid, but there was no appearance of condensed aqueous vapour in any part of it.

Quinia as has already been stated agrees with cinchonia in affording a large quantity of ammonia, when subjected to destructive distillation, and consequently, in containing nitrogen as one of its elements.

Having, as I conceive, satisfactorily established the non-existence of oxygen in cinchonia, I was induced to infer from analogy, that that element would not be found in quinia, and this opinion seemed justified by the apparent absence of aqueous vapour in the tubes in which it had been decomposed. But on passing the products of its decomposition through a long glass tube, containing fragments of rock crystal, and heated to bright redness, there appeared some slight traces of aqueous vapour in a portion of the tube cooled for the purpose of its condensation.

In the experiments made with a view of determining the ultimate components of quinia, there was also always a small loss of weight, which, from the above statement, may be referred to oxygen; but in five experiments very carefully repeated upon that substance, there were slight discrepancies of results, which induce me to give the following as, probably, an approximation only to the correct proportions of its elements.

Carbon	73.80
Nitrogen	13.00
Hydrogen	7.65
Oxygen	5.55
	100.

Morphia.—The results of three experiments made with a view to determine the ultimate composition of this substance, agree closely with each other; I have, therefore, no doubt of the accuracy of the following estimate of the relative proportions of its ultimate elements:—

Carbon	72.00
Nitrogen	5.50
Hydrogen	5.50
Oxygen	17.00
	100. *

When morphia is passed through a red-hot tube, it affords, as might be expected, a considerable portion of aqueous vapour, and when fused with potassium, or heated with it in naphtha, it manifests a very evident action upon that metal.

Strychnia.—The experiments which I have made upon this substance, induce me to regard it as resembling, in the nature of its ultimate elements, the preceding salifiable bases, but I have had no opportunity of ascertaining their relative proportions.

The strychnia which I examined, prepared by M. Robiquet, of Paris, was in small and imperfect octoëdral crystals; fusible as morphia, of a bitter taste, and intensely so when combined with an acid. Heated in a tube it decrepitates, fuses, becomes brown and black, ammonia and water being at the same time evolved. There can, therefore, be no doubt of the existence of carbon, nitrogen, hydrogen, and oxygen, in this substance.

It appears from the above experiments, that the peculiar salifiable bases, or alkaline substances, as they have been termed, separable from opium, from the varieties of cinchona, and from the *Nux Vomica*, resemble each other in containing nitrogen as a characteristic component part, and that consequently, when burned, they exhale an odour precisely resembling that of animal bodies, and like them afford ammonia, and some of its compounds, when subjected to distillation. There is another remarkable analogy which pervades this class of bodies, as far as they have hitherto

* M. Bussey, to whom we owe an analysis of morphia, gives the following as its components:—(*Annals of Philosophy*, vi. 229.)

Carbon	69.0
Nitrogen	4.5
Hydrogen	6.5
Oxygen	20.
	100

been examined, which is their very feeble saturating power in regard to the acids, or in other words, the high equivalent number by which they are represented.

In respect to cinchonia, 100 parts were found to require for saturation a quantity of diluted sulphuric acid, equivalent to 12.7 of real acid; of the sulphate of cinchonia thus obtained which crystallizes in quadrangular prisms without retaining water, 24 grains furnished by decomposition with muriate of baryta 8 grains of sulphate of baryta, equal to 2.72 sulphuric acid, so that upon these data the number 315 will be the prime equivalent of cinchonia, that of sulphuric acid being = 40. From the experiments of Messrs. Pelletier and Caventon, it appears that 100 parts of cinchonia saturate 13.02 of real sulphuric acid, proportions agreeing very nearly with those obtained in the laboratory of the Royal Institution, by Mr. Faraday.

Quinia saturates a still smaller quantity of the acids than cinchonia; by direct experiments, and by the analysis of the crystallized sulphate, 360 parts of quinia were found to neutralize 40 of real sulphuric acid.

The equivalent of morphia deduced from the experiments of MM. Pelletier and Caventou, (*Journal de Phar.*, v.) appears to be about 325, and that of strychnia 380. *Ann. de Chim. et Phys.* 155.)

These substances, therefore, arranged in the order of their saturating powers, stand in the following order, the annexed numbers being their prime equivalents in reference to hydrogen as unity,

Cinchonia	315
Morphia	325
Quinia	360
Strychnia	380

In detailing the above experiments, I have purposely avoided any allusion to the equivalent ratios in which the ultimate elements of the substances analyzed may be supposed to be associated, for I am not sufficiently convinced that the methods are susceptible of that extreme and rigorous accuracy which they should be, to serve as the foundations of so refined an application of the theory of proportionals.

It was my intention to have concluded this paper with some remarks upon the preparation of cinchonia and quinia, and upon the relative medical effects of these substances in their pure states and in the form of salts, but the experiments connected with these subjects not being yet complete, I shall reserve them for a future communication.

The cinchonia which I used in the above experiments, was prepared for me with much care, by Mr. Faraday, in the laboratory of the Royal Institution; and the quinia was made by Mr. Hennell, at Apothecaries' Hall, where considerable quantities of the sulphate of quinia have already been prepared for medical use. In the case of intermittent diseases the latter salt appears rising in reputation, and promises to come into as general use in this country as in France, where it is universally substituted for the bark in substance in cases of ague. Upon this subject some interesting details will be found, in a communication from Dr. Elliotson, to the Medico-Chirurgical Society, published in the twelfth volume of their *Transactions*.

ART. XIV. *Astronomical Phenomena arranged in order of Succession for the first Three Months of the Year* 1824, *computed for the Meridian and Parallel of Greenwich. By* James South, Esq., F.R.S.

CONVINCED that next to the daily corrections in right ascension and north polar distance of the 46 principal stars*, there is nothing so much wanted in our observatories as an Astronomical Ephemeris, and regretting some one more adequate to the task has not yet undertaken it, I avail myself of Mr. Brande's kindness, which enables me through the medium of this Journal, to present the public with a list of astronomical phenomena, arranged in order of succession, for the first three months of the year 1824: computed for the Meridian and Parallel of Greenwich.

* In the *Annals of Philosophy* for the present month, I have published the daily corrections in right ascension of 37 Stars of the Greenwich catalogue.

Knowing that to the various forms of time, under which astronomical notices are given, we may attribute the loss of many a valuable observation, the phenomena here registered are reduced to sidereal time.

The Right Ascension and Declination of the Sun, Moon, Planets and Stars, are given to the nearest minute.

The Sun's place is taken from the *Nautical Almanac.*—The places of Mercury, Venus and the Georgian, are computed from data, found in the same work; those of Mars, Jupiter and Saturn, are taken from *Schumacher's Ephemeris;* whilst that of Juno is derived from tables published by Mr. Groombridge.

The right ascension of the Moon, is computed from the nautical, as is also her Declination, corrections for parallax and refraction having been applied to it; the ephemeris is continued as far through each lunation, as it is probable she will be observed.

The differential stars, and their places, are taken from *Schumacher's Astronomische Nachrichten.*

The eclipses of Jupiter's Satellites are computed from the *Nautical Almanac,* the corresponding mean time is also given; to the notice of each eclipse the distance of the planet from his opposition is annexed, so that by a reference to the diagrams published in this Journal, the observer will instantly be informed where the Immersion or Emersion will take place.—The time is accurate to the nearest minute.

The Occultations of Stars by the Moon, and the consequent Emersions, are derived from the list published in the *Philosophical Magazine,*—because, however, our clocks shew right ascensions in *time,* not in *space,* the degrees and minutes there given, are here converted into time—and as for the purpose of identifying a star, it is generally advisable, that its place should be brought up to the period of observation nearly; this I have also done;—and as apparent time in an observatory is useless, till converted into sidereal or mean, it is here altogether rejected, and the two latter are substituted in its stead,—the calculations are considered accurate, to two or three minutes of time.

For the original list, we are obliged to Messrs. Inghirami

and Baily, to the former for having made the calculations, to the latter for having published them; and I trust neither the one, or the other, will feel displeasure because I have put them into a proper observatory dress.

That eclipses of stars of the 7th, 8th and 9th magnitudes may be observed I well know; but it must be remembered that identification of the star, is as essential as the observation.—Now considering the frequency with which stars, such as these, are diffused over the heavens, the effect which the lunar light has apparently to alter their natural splendour, and to obliterate from our sight the presence of all minute stars, which under other circumstances might materially assist us, I fear little confidence must be placed in identifications, unless made by instrumental assistance*. He who has a telescope mounted equatorially, will do well to place it upon some known star in the neighbourhood of the Moon, and though it may not be accurately adjusted, it will afford him a result which when compared with the actual place of the star, may be applied in the form of index error, to the observed place of the unknown star; hence a reference to the data furnished in this ephemeris, will generally inform him, how far his identification is complete.—Should the star be to the east of the meridian, he should endeavour, if possible, to get its transit over it the same evening, if to the west of it, he should procure it the first opportunity.

That the following pages are exempt from error, I dare not indulge the hope; I believe, however, they will be found generally accurate; the *practical* astronomer who knows what it is to observe all night, and to compute nearly all day, will I am sure pardon what is done amiss:—

* Gentlemen by their fire-sides, identify stars, however near to the Moon, easily enough; but Major Kater (on shore,) who has had no little experience in these matters, assures me, that it was not without considerable difficulty, he could identify α Scorpii; now this star is of the 3rd or 4th magnitude.—Again, Sir Thos. Brisbane and Mr. Rumker (at sea), transmitted to Europe, not long since, a novel observation, in the shape of an occultation of Mercury by the Moon, little suspecting that their *planet* Mercury was no other than the Star Regulus.

ASTRONOMICAL PHENOMENA arranged in Order of Succession, for the first Three Months of the Year 1824.

JANUARY.

Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time. H. M.	Planet's or Star's Declination. D. M.
1	Sun		18 41	23 5 S
	Mercury .		19 34	23 53 S
	Saturn . .		3 2	14 47 N
	Jupiter . .		6 24	23 17 N
	Venus . .		15 31	15 54 S
2	Sun		18 48	23 0 S
	Mercury .		19 41	23 31 S
	Saturn . .		3 2	14 46 N
	Jupiter . .		6 24	23 17 N
	Venus . .		15 36	16 9 S
3	Sun		18 53	22 51 S
	Mercury .		19 47	23 16 S
	Saturn . .		3 2	14 46 N
	Jupiter . .		6 23	23 18 N
	Venus . .		15 40	16 25 S
4	Sun		18 57	22 49 S
	Mercury .		19 54	22 57 S
	Im. * . . .	7	2 41 or 7^{h} 48' MT.	
	*'s R.A. 21^{h} 28' Decl. 12° 14' S. (14'N.)			
	Saturn . .		3 1	14 46 N
	Em. * . .		3 3 or 8^{h} 9' MT. (10'N.)	
	Jupiter . .		6 22	23 18 N
	Em. 1 Sat.		9 40 or 14^{h} 46' MT. (7)	
	Venus . .		15 45	16 40 S
5	Sun		19 2	22 42 S
	Mercury .		20 1	22 34 S
	Im. * . . .	4.5	22 46 or 3^{h} 49' MT.	
	*'s R.A. 22^{h} 8' Decl. 8° 39' S. (6'S.)			
	Em. * . .		23 26 or 4^{h} 29' MT.) 4's.)	
	Saturn . .		3 1	14 46 N
	Jupiter . .		6 22	23 19 N
	Venus . .		15 49	16 55 S
6	Sun		19 6	22 36 S
	Mercury .		20 8	22 11 S
	Saturn . .		3 1	14 46 N
	Em. 1 Sat.		4 16 or 9^{h} 14' MT. (9)	
	Jupiter . .		6 21	23 19 N
	Em. 2 Sat.		9 14 or 14^{h} 12' MT. (9)	
	Venus . .		15 54	17 11 S
7	Sun		19 10	22 29 S
	Mercury .		20 15	21 48 S
	16 Piscium	6	23 27	1 8 N
	17 Piscium	4.5	23 31	4 41 N
	Moon . . .		23 35	1 55 N
	22 Piscium	6	23 43	1 57 N
	Im. * . . .	6	1 10 or 6^{h} 5' MT.	
	*'s R.A. 23^{h} 37' Decl. 2° 28' N. (14'N.)			
	Em. * . .		2 7 or 7^{h} 1' MT. (1'N.)	
	Saturn . .		3 1	14 46 N
	Jupiter . .		6 21	23 20 N
	Venus . .		15 58	17 26 S
8	Sun		19 15	22 21 S
	Mercury .		20 21	21 21 S
	41 Piscium	5 6	0 12	7 13 N
	45	6	0 17	6 43 N
	Moon . . .		0 22	7 20 N
	O 135 . . .	8	0 30	6 57 N
	Saturn . .		3 1	14 46 N
	Jupiter . .		6 20	23 20 N
	Im. * . . .	7	7 3 or 11^{h} 53' MT.	
	*'s R.A. 0^{h} 32' Decl. 8° 21'N. (cont.)			
	Venus . .		16 3	17 40 S
9	Sun		19 19	22 13 S
	Mercury .		20 28	20 54 S
	72 Piscium	6	0 56	14 0 N
	O 311 . . .	6	1 1	14 14 N
	Moon . . .		1 10	12 31 N
	101 Pisces	6	1 26	13 46 N
	Saturn . .		3 1	14 45 N
	Jupiter . .		6 20	23 21 N
	Venus . .		16 7	17 54 S
10	Sun		19 24	22 5 S
	Mercury .		20 31	20 27 S
	I. 213 . . .	6	1 54	17 24 N
	I. 257 . . .	8	1 58	17 11 N
	Moon . . .		2 2	17 18 N
	θ Arietis .	7.8	2 9	18 53 N
	Saturn . .		3 1	14 45 N
	Jupiter . .		6 19	23 21 N
	Venus . .		16 12	18 8 S
11	Sun		19 28	21 56 S
	Mercury .		20 40	19 56 S
	Im. * 1 . .	7.8	23 13 or 1^{h} 22' MT.	
	*'s R.A. 2^{h} 54' Decl. 20° 47'N. (0')			
	Em. * 1 .		0 43 or 5^{h} 22' MT. (9's.)	
	ε Arietis .	5	2 49	20 38 N
	Moon . . .		2 59	21 17 N
	Saturn . .		3 1	14 15 N
	τ Arietis .	6	3 11	20 30 N
	66	6.7	3 18	22 12 N
	Im. * 2 . .	7	3 20 or 7^{h} 59' MT.	
	*'s R.A. 3^{h} 0' Decl. 21° 5'N. (cont.)			
	Im. * 3 .	7	3 21 or 8^{h} 0' MT.	
	*'s R.A. 3^{h} 1' Decl. 21° 13' N. (7' S.)			
	Em. * 3 .		3 43 or 8^{h} 22' MT. (13's.)	
	Im. * 4 . .	7	3 43 or 8^{h} 22' MT.	
	*'s R.A. 3^{h} 1' Decl. 21° 30' N. (7' N.)			
	Em. * 4 .		4 50 or 9^{h} 29' MT. (0')	
	Jupiter . .		6 18	23 21 N
	Em. 1 Sat.		12 3 or 16^{h} 40' MT. (11)	
	Venus . .		16 17	18 21 S
12	Sun		19 32	21 46 S
	Mercury .		20 46	19 26 S
	Im. * . . .	6.7	23 53 or 4 28 MT.	
	*'s R.A. 3^{h} 55' Decl. 21° 32 N. (2' N.)			

JANUARY.

Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time. H. M.	Planet's or Star's Declination. D. M.
	Im. 3 Sat		0 43	or 5^h 19' MT.(15)
	Em * . .		0 52	or 5^h 27' MT.(2's.)
	Saturn . .		3 1	14 46 N
	III. 179 . .	7.8	3 42	24 38 N
	Em. 3 Sat.		3 51	or 8^h 26' MT.(15')
	36 Tauri .	6.7	3 54	23 37 N
	Moon . . .		4 1	24 3 N
	ψ Tauri . .	6	4 12	25 12 N
	Jupiter . .		6 18	23 22 N
	Venus . .		16 21	18 35 S
13	Sun		19 37	21 37 S
	Mercury .		20 52	18 55 S
	Mars and γ Virg. dif. lat. 9'			
	Saturn . .		3 1	14 46 N
	κ Tauri . .	6	4 47	24 46 N
	IV. 287 . .	8	4 55	26 11 N
	Moon . . .		5 7	25 11 N
	118 Tauri .	7	5 18	25 0 N
	Jupiter . .		6 17	23 22 N
	Em. 1 Sat.		6 38	or 11^h 9' MT.(16)
	Im. * . . .	7	9 46	or 14^h 16' MT.
	*'s R.A. 5^h 18'			Decl. 25° 0' N. (5'S.)
	Em. * . .		10 35	or 15^h 5' MT.(1's.)
	Em. 2 Sat.		12 20	or 16^h 49' MT.(16)
	Venus . .		16 26	18 49 S
14	Sun		19 41	21 26 S
	Mercury .		20 57	18 23 S
	Im. * 1 . .	7	23 16	or 3^h 44' MT.
	*'s R.A. 6^h 1'			Decl. 24° 27' N. (1'N.)
	Em. * 1 .		0 3	or 4^h 30' MT.(0')
	Saturn . .		3 1	14 46 N
	5 Gem. . .	7	6 1	24 27 N
	8	7	6 6	24 1 N
	Moon . . .		6 16	24 21 N
	Jupiter . .		6 17	23 22 N
	VI. 166 . .	7.8	6 27	24 44 N
	Moon . . .		6 30	with Jupiter.
	Im. * 2 . .	7	11 7	or 15^h 33' MT.
	*'s R.A. 6^h 27'			Decl. 23° 39' N. (15'S.)
	Em. * 2 .		11 42	or 16^h 8' MT.(1'N.)
	Venus . .		16 31	19 1 S
15	Sun		19 45	21 16 S
	Mercury .		21 2	17 50 S
	Im. * 1 . .	3.4	0 37	or 5^h 1' MT.
	*'s R.A. 7^h 10'			Decl. 22° 18' N. (9'N.)
	Em. 1 Sat.		1 14	or 5^h 37' MT.(18)
	Em. * 1 .		1 14	or 5^h 38' MT.(12'N.)
	Saturn . .		3 1	14 46 N
	Im. * 2 . .	7.8	3 14	or 7^h 38' MT.
	*'s R.A. 7^h 16'			Decl. 21° 58' N. (4'N.)
	Im. * 3 . .	6	3 38	or 8^h 2' MT.
	*'s R.A. 7^h 17'			Decl. 21° 48' N. (7'N.)
	Em. * 2 .		4 12	or 8^h 35' MT.(1'N.)
	Em. * 3 .		4 35	or 8^h 58' MT.(2's.)
	Jupiter . .		6 16	23 22 N

Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time. H. M.	Planet's or Star's Declination. D. M.
	VII. 57 . .	3.4	7 10	22 18 N
	VII. 97 . .	7.8	7 16	21 53 N
	Moon . . .		7 24	21 31 N
	VII. 179 .	7	7 33	22 48 N
	Im. 4 Sat.		9 33	or 13^h 55' MT.(18)
	Em. of it .		11 22	or 15^h 44' MT.(18)
	Im. * 4. .		11 59	or 16^h 21' MT.
	*'s R.A. 7^h 35'			Decl. 20° 44' N. (6'N.)
	Em. * 4.		12 38	or 17^h 0' MT.(11'N.)
	Moon . . .		15 7	eclipsed.
	Venus . .		16 36	19 13 S
16	Sun		19 49	21 5 S
	Mercury .		21 7	17 18 S
	Saturn . .		3 1	14 46 N
	Jupiter . .		6 16	23 23 N
	25 Canc. .	6	8 16	17 37 N
	θ	5.6	8 22	18 41 N
	Moon . . .		8 29	16 57 N
	52 Canc. .	7.8	8 41	16 30 N
	Venus . .		16 41	19 25 S
17	Sun		19 54	20 54 S
	Mercury .		21 11	16 46 S
	Em. 2 Sat.		1 53	or 6^h 8' MT.(20)
	Saturn . .		3 1	14 46 N
	Im. * 1 . .	5	4 47	or 9^h 2' MT.
	*'s R.A. 9^h 22'			Decl. 12° 5' N. (7'S)
	Em. * 1 .		5 45	or 10^h 0' MT.(7'N.)
	Jupiter . .		6 15	23 23 N
	Im. * 2 . .	7	8 11	or 12^h 25' MT.
	*'s R.A. 9^h 29'			Decl. 11° 34' N. (18'N.)
	Em. * 2 .		8 26	or 12^h 40' MT.(16'N.)
	IX. 35 . .	7	9 8	12 14 N
	ζ Leonis .	5	9 22	12 5 N
	Moon . . .		9 30	11 12 N
	19 Leonis	7	9 38	12 23 N
	Im. * 3 . .	4	10 12	or 14^h 26' MT.
	*'s R.A. 9^h 32'			Decl. 10° 41' N. (16'S.)
	Em. * 3 .		10 37	or 14^h 51' MT.(4's.)
	Venus . .		16 45	19 36 S
18	Sun		19 58	20 42 S
	Mercury .		21 14	16 15 S
	Im. * 1 . .	6	2 53	or 7^h 5' MT.
	*'s R.A. 10^h 14'			Decl 6° 35' N. (1'N)
	Saturn . .		3 1	14 47 N
	Em. * 1 .		3 38	or 7^h 50' MT.(12'N.)
	Jupiter . .		6 15	23 24
	Im. * 2 . .		7 8	or 11^h 19' MT.
	*'s R.A. 10^h 28'			Decl. 5° 33' N. (0')
	Em. * 2 .		8 4	or 12^h 15' MT.(14'N.)
	Moon . . .		10 27	4 46 N
	Im. * 3 . .	6	14 47	or 18^h 57' MT.
	*'s R.A. 10^h 36'			Decl. 3° 15' N. (6'S.)
	Em. * 3 .		15 44	or 19^h 54' MT.(9'N.)
	Venus . .		16 50	19 48 S
19	Sun		20 2	20 30 S

JANUARY.

Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time. H. M.	Planet's or Star's Declination. D. M.
	Mercury .		21 18	15 43 S (Gr.El.)
	Saturn . .		3 1	14 47 N
	Im. 3 Sat.		5 11 or 9^{h} 18′ MT. (22)	
	Jupiter . .		6 14	23 24 N
	Em. 3 Sat.		8 19 or 12^{h} 26′ MT. (22)	
	Venus . .		16 55	20 0 S
20	Sun		20 7	20 17 S
	Mercury .		21 20	15 15 S
	Saturn . .		3 1	14 47 N
	Jupiter . .		6 14	23 24 N
	Em. 1 Sat.		9 1 or 13^{h} 3′ MT. (23)	
	Venus . .		17 0	20 8 S
21	Sun		20 11	20 4 S
	Mercury .		21 23	14 48 S
	Saturn . .		3 1	14 47 N
	Jupiter . .		6 13	23 25 N
	Venus . .		17 5	20 17 S
22	Sun		20 15	19 51 S
	Mercury .		21 25	14 21 S
	Saturn . .		3 1	14 48 N
	Em. 1 Sat.		3 36 or 7^{h} 32′ MT. (25)	
	Jupiter . .		6 13	23 25 N
	Im. * 1 . .	9	11 46 or 15^{h} 40′ MT.	
	*'s R.A. 13^{h} 57′ Decl. 18° 26′ S. (16′S)			
	Em. * 1 .		12 3 or 15^{h} 57′ MT.) 7′s.)	
	Im. * 2 . .		12 24 or 16^{h} 18′ MT.	
	*'s R.A. 13^{h} 59′ Decl. 18° 24′ S. (5′S.)			
	Em. * 2 .		13 36 or 17^{h} 30′ MT. (9′N.)	
	Venus . .		17 10	20 25 S
23	Sun		20 19	19 37 S
	Mercury .		21 25	14 1 S
	Saturn . .		3 1	14 48 N
	Jupiter . .		6 12	23 25 N
	Im. * 1 . .	7 8	10 37 or 14^{h} 27′ MT.	
	*'s R.A. 14^{h} 49′ Decl. 21° 41′ S. (1′N.)			
	Em. * 1 .		11 30 or 15^{h} 20′ MT. (12′N)	
	Im. * 2 . .	7	14 31 or 18^{h} 21′ MT.	
	*'s R.A. 14^{h} 55′ Decl. 22° 19′ S. (3′N.)			
	Im. * 3 . .	7	15 12 or 19^{h} 2′ MT.	
	*'s R.A. 14^{h} 56′ Decl. 22° 38′ S. (9′N.)			
	Em. * 2 .		15 50 or 19^{h} 40′ MT. (12′N.)	
	Em. * 3 .		16 22 or 20^{h} 12′ MT. (1′s.)	
	Venus . .		17 14	20 33 S
24	Sun		20 23	19 23 S
	Mercury .		21 26	13 42 S
	Saturn . .		3 1	14 49 N
	Em. 2 Sat.		4 58 or 8^{h} 46′ MT. (27)	
	Jupiter . .		6 12	23 26 N
	Im. * 1 . .	5	11 34 or 15^{h} 20′ MT.	
	*'s R.A. 15^{h} 43′ Decl. 24° 48′ S. (14′S)			
	Im. * 2 . .	6	11 49 or 15^{h} 35′ MT.	
	*'s R.A. 15^{h} 44′ Decl. 24° 48′ S. (7′N.)			
	Im. * 3 . .	6	11 55 or 15^{h} 41′ MT.	

Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time. H. M.	Planet's or Star's Declination. D. M.
	*'s R.A. 15^{h} 44′ Decl. 24° 43′ S. (6′S.)			
	Em. * 1 .		12 20 or 16^{h} 6′ MT. (7′s.)	
	Em. * 2 .		12 54 or 16^{h} 40′ MT. (1′s.)	
	Em. * 3 .		13 1 or 16^{h} 47′ MT. (2′N.)	
	Venus . .		17 19	20 42
25	Sun		20 28	19 9 S
	Mercury .		21 26	13 22
	Saturn . .		3 1	14 49 N
	Jupiter . .		6 12	23 26 N
	Im * . . .	7 8	13 18 or 17^{h} 1′ MT.	
	*'s R.A. 16^{h} 32′ Decl. 26° 18′ S. (cont.)			
	Venus . .		17 24	20 50 S
26	Sun		20 32	18 54 S
	Mercury .		21 24	13 12 S
	Saturn .		3 1	14 50 N
	Jupiter . .		6 11	23 26 N
	Im. 3 Sat.		9 40 or 13^{h} 19′ MT. (29)	
	Em. 3 Sat.		12 49 or 16^{h} 27′ MT. (29)	
	Venus . .		17 29	20 55 S
27	Sun		20 36	18 39 S
	Mercury .		21 22	13 2 S
	Saturn . .		3 1	14 50 N
	Jupiter . .		6 11	23 26 N
	Em. 1 Sat.		11 23 or 14^{h} 58′ MT. (30)	
	Venus . .		17 34	21 1 S
28	Sun		20 40	18 23 S
	Mercury .		21 20	12 58 S
	Saturn . .		3 1	14 51 N
	Jupiter . .		6 10	23 27 N
	Im. * . . .	7.8	15 26 or 18 56 MT.	
	*'s R.A. 19^{h} 22′ Decl. 23° 6′ S. (8′N.)			
	Em. * . .		16 30 or 20^{h} 0′ MT. (7′N.)	
	Venus . .		17 39	21 6 S
29	Sun		20 44	18 8 S
	Mercury .		21 16	12 56 S
	Saturn . .		3 1	14 51 N
	Em. 1 Sat.		5 59 or 9^{h} 27′ MT. (32)	
	Jupiter . .		6 10	23 27 N
	Im * . . .	5.6	15 36 or 19^{h} 2′ MT.	
	*'s R.A. 20^{h} 9′ Decl. 19° 40′ S. (cont.)			
	Venus. . .		17 44	21 11 S
30	Sun		20 48	17 51 S
	Mercury .		21 13	12 58 S
	Saturn . .		3 1	14 52 N
	Jupiter . .		6 10	23 27 N
	Venus . .		17 49	21 16 N
31	Sun		20 52	17 35 S
	Mercury .		21 9	13 1 S
	Saturn . .		3 1	14 53 N
	Jupiter . .		6 9	23 27 N
	Em. 2 Sat.		8 4 or 11^{h} 23′ MT. (34)	
	Venus. . .		17 54	21 22 S

FEBRUARY.

Days.	Planet's or Star's Name, &c.	Magnitude of Stars	Sidereal Time H. M.	Planet's or Star's Declination D. M.
1	Sun		20 57	17 18 S
	Mercury. .		21 5	13 10 S
	Jupiter and	11	Gemini, dif. lat. 8'	
	Saturn . .		3 1 or	14 53 N
	Im. 4 Sat.		4 39 or $7^h 55'$MT (35)	
	Jupiter . .		6 9	23 27 N
	Em. 4 Sat.		6 41	$10^h 0'$MT.(35)
	Mars . . .		12 50	2 4 S
	Venus . .		17 53	21 27 S
2	Sun		21 1	17 1 S
	Saturn . .		3 1	14 54 N
	Jupiter . .		6 9	23 28 N
	Mars . . .		12 50	2 7 S
	Venus - .		18 4	21 29 S
	Mercury .		20 55	13 42 S (Inf. C.)
3	Sun . .		21 5	16 44 S
	Im. * . .	9	2 42 or $5^h 50'$MT.	
	*'s R.A. 23^h 25'		Decl. 1° 2' N. (13'N.)	
	Saturn . .		3 1	14 55 N
	Em. * . .		3 40 or $6^h 48'$MT (0')	
	Im. * . . .	6	3 55	$7^h 1'$MT.
	*'s R.A. 23^h 27'		Decl. 1° 8' N. (10'N.)	
	Em. . . .		4 12 or $7^h 20'$MT.(14'N.)	
	Jupiter . .		6 8	23 28 N
	Mars . . .		12 51	2 9 S
	Venus . .		18 9	21 31 S
	Mercury .		20 51	13 58 S
4	Sun		21 9	16 26 S
	Saturn . .		3 2	14 56 N
	Jupiter . .		6 8	23 28 N
	Im. * . . .	6	6 40 or $9^h 44'$MT.	
	*'s R.A. 0^h 17'		Decl. 6° 43' N. (7'S.)	
	Em. . .		7 14 or $10^h 18'$MT (14's.)	
	Mars . . .		12 51	2 11 S
	Venus . .		18 14	21 33 S
	Mercury .		20 46	14 14 S
5	Sun		21 13	16 8 S
	Saturn . .		3 2	14 56 N
	Jupiter . .		6 8	23 28 N
	Em. 1 Sat.		8 22 or $11^h 22'$MT.(39)	
	Mars . . .		12 52	2 13 S
	Venus . .		18 19	21 34 S
	Mercury .		20 42	14 32 S
6	Sun		21 17	15 50 S
	Moon . . .		1 42	16 34 N
	Saturn . .		3 2	14 57 N
	Jupiter . .		6 7	23 28 N
	Mars . . .		12 52	2 14 S
	Venus . .		18 24	21 36 S
	Mercury .		20 38	14 51 S
7	Sun		21 21	15 32 N
	ν Arietis .	5.6	2 29	21 12 N
	Moon . .		2 37	19 46 N
	47 Arietis	6	2 48	19 57 N
	Em. 1 Sat.		2 58 or $5^h 51'$MT.(41)	

Days.	Planet's or Star's Name, &c.	Magnitude of Stars	Sidereal Time H. M.	Planet's or Star's Declination D. M.
	II. 261 . .	7	2 59	20 5 N
	Saturn . .		3 2	14 58 N
	Jupiter . .		6 7	23 29 N
	Im. * . . .	5	9 0 or $11^h 51'$MT.	
	*'s R.A. 2^h 49'		Decl. 20° 38' N. (8'N.)	
	Em. . . .		9 57 or $12^h 48'$MT.(5'N.)	
	Em. 2 Sat.		11 9	$14^h 1'$MT.(11)
	Mars . . .		12 53	2 16 S
	Venus . .		18 29	21 38 S
	Mercury .		20 35	15 9 S
8	Sun		21 25	15 13 S
	Saturn . .		3 2	14 59 N
	7 Tauri . .	6	3 21	23 52 N
	Moon . . .		3 31	22 57 N
	III. 172. .	7.8	3 40	23 25 N
	33 Tauri .	6.7	3 47	22 39 N
	Im. * 1 . .	5	4 51 or $7^h 40'$MT.	
	*'s R.A. 3^h 36'		Decl. 23° 21' N. (cont.)	
	Im. * 2 . .	7.8	5 43 or $8^h 32'$MT.	
	*'s R A. 3^h 38'		Decl. 23° 19' N. (10'S.)	
	Im. * 3 . .	8.9	5 55 or $8^h 44'$MT.	
	*'s R.A. 3^h 39'		Decl. 23° 21' N. (11'N.)	
	Im. * 4 . .		6 2 or $8^h 51'$MT.	
	*'s R.A. 3^h 39'		Decl 23° 10' N. (0')	
	Jupiter . .		6 7	23 29 N
	Im. * 5 . .	8	6 10 or $8^h 59'$MT.	
	*'s R.A. 3^h 40'		Decl. 23° 18' N. (7'S.)	
	Im * 6 . .	5	6 17 or $9^h 6'$MT.	
	*'s R.A. 3^h 39'		Decl. 23° 30' N. (cont.)	
	Em. * 2 .		6 38 or $9^h 27'$MT.(6's.)	
	Em. * 3 .		6 47 or $9^h 36'$MT (8'N.)	
	Im. * 7 .	7.8	6 48 or $9^h 37'$MT.	
	*'s R.A. 3^h 40'		Decl. 23° 25' N. (12'N.	
	Em. * 4 .		7 3 or $9^h 52'$MT.(1's.)	
	Em. * 5 .		7 10 or $9^h 59'$MT.(1's.)	
	Em. * 7 .		7 31 or $10^h 20'$MT.(9'N.)	
	Im. * 8 .	7	10 10 or $12^h 58'$MT.(13'N.)	
	*'s R.A. 3^h 48'		Decl. 23° 24' N	
	Em. * 8 .		10 39 or $13^h 27'$MT.(13'N.)	
	Mars . . .		12 53	2 17 S
	Venus . .		18 34	21 36 S
9	Mercury .		20 32	15 27 S
	Sun		21 29	14 54 S
	Saturn . .		3 2	15 0 N
	Moon . . .		4 36	24 47 N
	98 Tauri .	6	4 47	24 46 N
	IV. 287 . .	8	4 55	26 11 N
	IV. 295 . .	6	4 57	24 1 N
	Jupiter . .		6 7	23 29 N
	Im. * . . .	7	7 46 or $10^h 31'$MT.	
	*'s R.A. 4^h 43'		Decl. 25° 4' N. (12'N.)	
	Em. . . .		8 18 or $11^h 2'$MT.(13'N.)	
	Im. * . . .	6	9 35 or $12^h 19'$MT.	
	*'s R.A. 4^h 47'		Decl. 24° 46' N. (4'S.)	
	Em.		10 30 or $13^h 14'$MT.(2's.)	
	Mars . . .		12 53	2 18 S

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Days.	Planet's or Star's Name, &c.	Magnitude of Stars	Sidereal Time. H. M.	Planet's or Star's Declination. D. M.
	Venus . .		18 39	21 34 S
	Mercury .		20 29	15 44 S
10	Sun		21 33	14 35 S
	Saturn . .		3 2	15 1 N
	125 Tauri .	6	5 29	25 47 N
	V. 214 . .	7.8	5 37	24 37 N
	Moon . . .		5 41	24 56 N
	139 Tauri.	5.6	5 47	25 55 N
	Jupiter . .		6 6	23 29 N
	Im. * . . .	8	8 30	or 11h 10′ MT.
	*'s R.A. 5h 48′ Decl. 24° 34′ N. (13′S.)			
	Em.		9 9	or 11h 49′ MT. (10′s.)
	Mars . . .		12 51	2 18 S
	Im. * . . .	7	13 39	or 16h 19′ MT.
	*'s R.A. 6h 1′ Decl. 24° 27′ N. (13′N.)			
	Em.		14 0	or 16h 40′ MT. (15′N.)
	Venus . ,		18 44	21 32 S
	Mercury .		20 26	16 2 S
11	Sun		21 37	14 15 S
	Saturn . .		3 2	15 2 N
	Jupiter . .		6 6	23 29 N
	Moon . . .		6 48	23 11 N
	44 Gem. .	6.7	6 55	22 54 N
	48 Gem. .	6	7 2	24 25 N
	58 Gem. .		7 13	23 17 N
	Im. * . . .	6.7	9 32	or 12h 8′ MT.
	*'s R.A. 6h 53′ Decl. 22° 54′ N. (4′N.)			
	Em.		10 25	or 13h 1′ MT. (9′s.)
	Mars . . .		12 54	2 18 S
	Venus . .		18 50	21 30 S
	Mercury .		20 25	16 17 S
12	Sun		21 41	13 56 S
	Saturn . .		3 3	15 3 N
	Im. * . . .	6.7	3 20	or 5h 53′ MT.
	*'s R.A. 7h 45′ Decl. 20° 20′ N. (6′N.)			
	Em. . . .		4 9	or 6h 42′ MT. (12′N.)
	Jupiter . .		6 6	23 29 N
	79 Gem. .	7	7 35	20 44 N
	VII. 224 .	7	7 42	19 46 N
	85 Gem. .	6.7	7 45	20 20 N
	Moon . . .		7 53	19 39 N
	Em. 1 Sat.		10 45	or 13h 17′ MT. (46)
	Mars . . .		12 54	2 18 S
	Im. * . . .	7	13 14	or 15h 46′ MT.
	*'s R.A. 8h 4′ Decl. 18° 12′ N. (cont.)			
	Im. * . . .	8	13 44	or 16h 10′ MT.
	*'s R.A. 8h 6′ Decl. 18° 5′ N. (cont.)			
	Venus . .		18 55	21 28 S
	Mercury .		20 24	16 32 S
13	Sun		21 45	13 36 S
	Saturn , .		3 3	15 4 N
	Jupiter . .		6 6	23 30 N
	Im. * . . .	8.9	6 40	or 9h 9′ MT.
	*'s R.A. 8h 54′ Decl. 14° 52′ N. (6′N.)			
	Em. . . .		7 43	or 10h 12′ MT. (8′s.)
	VIII. 208 .	8	8 46	14 51 N
	VIII. 225 .	8	8 50	13 45 N
	Moon . . .		8 56	14 31 N
	π Cancri .	6.7	9 3	15 42 N
	Mars . . .		12 54	2 18 S
	Stationary near λ Virginis.			
	Im. * . . .	8	14 45	or 17h 13 MT.
	*'s R.A. 9h 9′ Decl. 13° 3′ N. (4′S.)			
	Em. . . .		15 24	or 17h 52′ MT. (11′s.)
	Venus . .		19 0	21 26 S
	Mercury .		20 24	16 47 S
14	Sun		21 48	13 16 S
	Saturn . .		3 3	15 5 N
	Im. * . . .	6	4 31	or 6h 56′ MT.
	*'s R.A. 9h 47′ Decl. 9° 46′ N. (10′S.)			
	Em. . . .		4 46	or 7h 11 MT. (16′s.)
	Em. 4 Sat.		5 21	or 7h 46 MT. (48)
	Im. * . . .	6	5 30	or 7h 55 MT.
	*'s R.A. 9h 49′ Decl. 9° 9′ N. (15′N.)			
	Jupiter . .		6 6	23 30 N
	Em. * . .		6 13	or 8h 38′ MT. (5′N)
	Im. * . . .	4.5	6 36	or 9h 1′ MT.
	*'s R.A. 9h 51′ Decl. 8° 53′ N. (15′N.)			
	Em. . . .		7 22	or 9h 47′ MT. (5s.
	IX. 202 . .	8	9 45	8 54 N
	11 Sext. .	6	9 49	9 9 N
	Moon . . .		9 56	8 23 N
	X. 51 . . .	7.8	10 13	9 51 N
	Mars . . .		12 54	2 18 S
	Venus . .		19 5	21 20 S
	Mercury .		20 24	16 58 S
15	Sun		21 52	12 55 S
	Saturn . .		3 3	15 6 N
	Im. * . . .	7	4 59	or 7h 20′ MT.
	*'s R.A. 10h 44′ Decl. 3° 2′ N. (10′S.)			
	Em. . . .		5 54	or 8h 15′ MT. (4′N.
	Jupiter . .		6 5	23 30 N
	Im. * . . .	7	8 6	or 10h 27′ MT.
	*'s R.A. 10h 46′ Decl. 2° 41′ N. (cont.			
	36 Sext. .	6	10 36	3 15 N
	55 Leonis.	6	10 47	1 40 N
	Moon . . .		10 53	1 44 N
	75 Leonis.	5.6	11 8	2 59 N
	Mars . . .		12 54	2 17 S
	Venus . .		19 10	21 15 S
	Mercury .		20 25	17 9 S
16	Sun		21 56	12 35 S
	Saturn . .		3 3	15 7 N
	Jupiter . .		6 5	23 30 N
	XI. 167. .	6	11 42	4 21 S
	XI. 168. .	8	11 46	4 9 S
	Moon . . .		11 49	4 56 S
	XI. 221 . .	7.8	11 55	4 30 S

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Days.	Planet's or Star's Name, &c.	Magnitude of Stars	Sidereal Time. H. M.	Planet's or Star's Declination. D. M.
	Mars . . .		12 54	2 16 S
	Venus. . .		19 15	21 9 S
	Mercury .		20 25	17 20 S
17	Sun		22 0	12 14 S
	Saturn . .		3 4	15 8 N
	Jupiter . .		6 5	23 30 N
	Mars . . .		12 54	2 15 S
	Venus . .		19 20	21 4 S
	Mercury .		20 27	17 27 S
18	Sun		22 4	11 53 S
	Saturn . .		3 4	15 8 N
	Em. 2 Sat		3 47 or 5^h 56′ MT. (52)	
	Jupiter . .		6 5	23 30
	Im. * . . .	6 7	8 58 or 11^h 6′ MT.	
	*'s R.A. 13^h 31′ Decl. 15° 33′ S. (1′N.)			
	Em. . . .		9 28 or 11^h 36′ MT. (8′N.)	
	Mars . . .		12 54	2 13 S
	Venus . .		19 25	20 59 S
	Mercury .		20 28	17 33 S
19	Sun		22 8	11 32 S
	Saturn . .		3 4	15 11 N
	Jupiter . .		6 5	23 30 N
	Mars . . .		12 54	2 11 S
	Em. 1 Sat.		13 8 or 15^h 12′ MT. (53)	
	Venus . ,		19 30	20 58 S
	Mercury .		20 30	17 40 S
20	Sun		22 12	11 11 S
	Saturn . .		3 4	15 12 N
	Jupiter . .		6 5	23 31 N
	Mars . . .		12 54	2 9 S
	Venus . .		19 35	20 41 S
	Mercury .		20 33	17 42 S
21	Sun		22 16	10 49 S
	Saturn . .		3 5	15 13 N
	Jupiter . .		6 5	23 31 N
	Em. 1 Sat.		7 44 or 9^h 41′ MT. (55)	
	Mars . . .		12 54	2 7 S
	Venus . .		19 40	20 35 S
	Mercury .		20 36	17 45 S
22	Sun		22 19	10 27 S
	Saturn . .		3 5	15 14 N
	Jupiter . .		6 5	23 31 N
	Mars . . .		12 53	2 4 S
	Im. * 1 . .	6.7	15 53 or 17^h 45′ MT.	
	*'s R.A. 17^h 21′ Decl. 26° 7′ S. (14′N.)			
	Im. * 2 . .	7	16 9 or 18^h 1′ MT.	
	*'s R.A. 17^h 21′ Decl. 26° 7′ S. (14′N.)			
	Em. * 2. .		16 36 or 18^h 28′ MT. (14′N.)	
	Em. * 1 .		16 47 or 18^h 39′ MT. (14′N.)	
	Venus . .		19 45	20 26 S
	Mercury .		20 39	17 47 S
23	Sun		22 23	10 6 S
	Saturn . .		3 5	15 16 N
	Jupiter . .		6 5	23 31 N
	Mars . . .		12 53	2 1 S
	Im. * . . .	4	17 43 or 19^h 31′ MT.	
	*'s R.A. 18^h 17′ Decl. 25° 30′ S. (4′S.)			
	Em. . . .		19 9 or 20^h 56′ MT. (0′)	
	Venus . .		19 51	20 16 S
	Mercury .		20 42	17 45 S
24	Sun . . , .		22 27	9 41 S
	Saturn . .		3 5	15 17 N
	Jupiter . .		6 5	23 31 N
	Em. 3 Sat.		6 43 or 8^h 29′ MT. (58)	
	Mars . . .		12 53	1 58 S
	Venus . .		19 56	20 7 S
	Mercury .		20 46	17 42 S
25	Sun		22 31	9 21 S
	Saturn . .		3 6	15 18 N
	Jupiter . .		6 5	23 31 N
	Em. 2 Sat.		6 52 or 8^h 33′ MT. (59)	
	Mars . . .		12 52	1 55 S
	Venus . .		20 1	19 58 S
	Mercury .		20 49	17 40 S
26	Sun		22 35	8 59 S
	Saturn . .		3 6	15 20 N
	Jupiter . .		6 5	23 31 N
	Mars . . .		12 52	1 51 S
	Venus . .		20 6	19 46 S
	Mercury .		20 53	17 31 S
27	Sun		22 38	8 37 S
	Saturn . .		3 6	15 21 N
	Jupiter . .		6 5	23 31 N
	Mars . . .		12 51	1 47 S
	Venus . .		20 11	19 33 S
	Mercury .		20 58	17 29 S
28	Sun		22 42	8 14 S
	Saturn . .		3 6	15 22 N
	Jupiter . .		6 5	23 31 N
	Em. 1 Sat.		10 7 or 11^h 36′ MT (62.)	
	Mars . . .		12 51	1 43 S
	Venus . .		20 16	19 21 S
	Mercury .		21 2	17 23 S (Gr.El.)
29	Sun		22 46	7 52 S
	Saturn . .		3 7	15 24 N
	Jupiter .		6 5	23 32 N
	Mars . . .		12 50	1 38 S
	Venus . .		20 21	19 9 S
	Mercury .		21 6	17 16 S

MARCH.

Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time. H. M.	Planet's or Star's Declination. D. M.
1	Sun		22 50	7 29 S
	Im *	6.7	4 58 or 6^{h} 20' M T.	
	*'s R.A. 23^{h} 14'		Decl. 0° 40'S. (cont.)	
	Jupiter		6 5	23 32 N
	Mars		12 49	1 33 S
	Venus		20 26	18 56 S
	Mercury		21 10	17 3 S
2	Sun		22 53	7 6 S
	Jupiter		6 5	23 32 N
	Im. 3 Sat.		8 0 or 9^{h} 18' M T. (65)	
	Em		11 13 or 12^{h} 30' M T. (65)	
	Mars		12 48	1 28 S
	Venus		20 31	18 41 S
	Mercury		21 15	16 49 S
3	Sun		22 57	6 43 S
	Jupiter		6 5	23 32 N
	Em. 2 Sat.		9 57 or 11^{h} 10' M T. (66)	
	Mars		12 48	1 23 S
	Venus		20 36	18 25 S
	Mercury		21 20	16 35 S
4	Sun		23 1	6 20 S
	Jupiter		6 5	23 32 N
	Mars		12 47	1 17 S
	Venus		20 41	18 10 S
	Mercury		21 25	16 21 S
5	Sun		23 4	5 57 S
	Jupiter		6 5	23 32 N
	Im. * 1	7	7 18 or 8^{h} 24' M T.	
	*'s R.A. 2^{h} 29'		Decl. 18° 58' N. (3'N.)	
	Em. * 1		8 10 or 9^{h} 16' M T. (9'N.)	
	Im. * 2	6	9 3 or 10 59 M T.	
	*'s R.A. 2^{h} 28'		Decl. 19° 15' N. (3'S.)	
	Em. * 2		9 53 or 10^{h} 59' M T. (2'N.)	
	Mars		12 46	1 12 S.
	Venus		20 46	17 55 S
	Mercury		21 30	16 4 S
6	Sun		23 8	5 34 S
	Moon		3 15	21 51 N
	Im. * 1	6.7	4 41 or 5^{h} 43' M T.	
	*'s R.A. 3^{h} 18'		Decl. 22° 12' N. (9'S.)	
	Em. * 1		5 41 or 6^{h} 46' M T. (3'S.)	
	Jupiter		6 5	23 32 N
	Im. * 2	7	9 27 or 10^{h} 28' M T.	
	*'s R.A. 3^{h} 27'		Decl. 22° 38'N. (cont.)	
	Im. * 3	6.7	10 2 or 11^{h} 3' M T.	
	*'s R.A. 3^{h} 28'		Decl. 22° 5'N (cont.)	
	Em. 1 Sat.		12 30 or 13^{h} 31' M T. (69)	
	Mars		12 45	1 6 S
	Venus		20 51	17 39 S
	Mercury		21 36	15 46 S
7	Sun		23 12	5 10 S
	Moon		4 15	24 10 N
	Jupiter		6 5	23 32 N
	Mars		12 44	1 0 S
	Venus		20 56	17 24 S
	Mercury		21 41	15 29 S
8	Sun		23 16	4 47 S
	Im. * 1	7	4 17 or 5^{h} 12' M T.	
	*'s R.A. 5^{h} 18'		Decl. 25° 0' N. (7'N.)	
	Moon		5 17	24 54 N
	V. 115	8	5 21	26 51 N
	Em. * 1		5 21 or 6^{h} 15' M T. (6'N.)	
	121 Tauri	6	5 25	23 55 N
	125	6	5 29	25 47 N
	Jupiter		6 6	23 32 N
	Em. 1 Sat.		7 6 or 8^{h} 0' M T. (71)	
	Mars		12 43	0 53 S
	Im. * 2	7.8	12 49 or 13^{h} 42' M T.	
	*'s R.A. 5^{h} 37'		Decl. 24° 37' N. (10'N.)	
	Im. * 3	5	13 18 or 14^{h} 11' M T.	
	*'s R.A. 5^{h} 38'		Decl. 24° 30' N. (4'N.)	
	Em. * 2		13 29 or 14^{h} 22' M T. (12'N.)	
	Em. * 3		13 57 or 14^{h} 50' M T. (8'N.)	
	Venus		21 1	17 6 S
	Mercury		21 47	15 7 S
9	Sun		23 19	4 23 S
	Jupiter		6 6	23 32 N
	8 Gem.	7	6 6	24 1 N
	VI. 67		6 11	23 50 N
	Moon		6 20	23 57 N
	V. 168	7.8	6 28	24 36 N
	Im. * 1	7	7 51 or 8^{h} 41' M T.	
	*'s R.A. 6^{h} 27'		Decl. 23° 39' N. (7' S.)	
	Em. * 1		8 56 or 9^{h} 46' M T (0')	
	Im. * 2	7	11 45 or 12^{h} 35' M T.	
	*'s R.A. 6^{h} 34'		Decl. 23° 0'N. (cont.)	
	Im. 3 Sat.		12 29 or 13^{h} 18' M T. (72)	
	Im. * 3	7	12 36 or 13^{h} 26' M T.	
	*'s R.A. 6^{h} 36'		Decl. 23° 33'N. (cont.)	
	Mars		12 42	0 47 S
	Venus		21 6	16 48 S
	Mercury		21 52	14 46 S
10	Sun		23 23	4 0 S
	Jupiter		6 6	23 32 N
	56 Gem.	5.6	7 12	20 46 N
	VII. 97	7.8	7 16	21 53 N
	Moon		7 24	21 17 N
	79 Gem.	7	7 35	20 41 N
	Mars		12 41	0 40 S
	Mars and χ Virg. dif. Lat. insensible			
	Em. 2 Sat.		13 2 or 13^{h} 47' M T. (73)	
	Im. *	7	14 57 15^{h} 42 M T	
	*'s R.A. 7^{h} 42'		Decl. 19° 46' (13'N.)	
	Em.		15 43 or 16^{h} 27' M T. (3'N.)	
	Venus		21 11	16 30 S
	Mercury		21 58	14 24 S
11	Sun		23 27	3 36 S
	Jupiter		6 6	23 33 N
	25 Cancri	6	8 16	17 37 N
	θ	5.6	8 23	18 41 N

MARCH.

Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time. H. M.	Planet's or Star's Declination. D. M.
	Moon . . .		8 26	17 2 N
	52 Cancri	7.8	8 41	16 39 N
	Mars . . .		12 40	0 33 S
	Venus . .		21 16	16 11 S
	Mercury .		22 3	13 58 S
12	Sun		23 30	3 13 S
	Jupiter . .		6 6	23 33 N
	Im. * 1 . .	5	6 45 or 7^h 21' M T.	
	*'s R.A. 9^h 22'		Decl. 12° 5' N. (8'S.)	
	Em. * 1 .		7 48 or 8^h 26' M T (10' N.)	
	ζ Leonis .	5	9 22	12 5 N
	Moon . . .		9 26	11 34 N
	18 Leonis	6	9 37	12 37 N
	IX. 184 . .	8	9 40	11 56 N
	Im. * 2 . .	4	12 8 or 12^h 46' M T.	
	*'s R.A. 9^h 32'		Decl. 10° 41' N. (11'S.)	
	Mars . . .		12 39	0 26 S
	Em. * 2 .		13 7 or 13^h 45' M T. (3' N.)	
	Venus . .		21 21	15 53 S
	Mercury .		22 8	13 33 S
13	Sun		23 34	2 49 S
	Jupiter . .		6 7	23 33 N
	Im. * 1 .	7	9 31 or 10^h 5' M T.	
	*'s R.A. 10^h 23'		Decl. 5° 33' N. (10'N.)	
	19 Sext. .	7	10 4	5 29 N
	Em. * 1 .		10 11 or 10^h 45' M T. (16' N)	
	Moon . . .		10 24	5 18 N
	35 Sext. .	7	10 34	5 40 N
	38 Sext. .	7	10 38	7 16 N
	Mars . . .		12 38	0 19 S
	Im. * 2 . .	6	16 35 or 17^h 8' M T.	
	*'s R A. 10^h 36'		Decl. 5° 15 N. (9'S.)	
	Em. * 2 .		17 27 or 18^h 0' M T. (5' N.)	
	Venus . .		21 25	15 35 S
	Mercury .		22 14	13 7 S
14	Sun		23 38	2 26 S
	Jupiter .		6 7	23 33 N
	Moon . .		11 19	1 21 S
	91 Leonis	4.5	11 28	0 9 N
	XI. 182 . .	8	11 46	0 27 S
	XI. 213 . .	7	11 52	0 46 S
	Mars . . .		12 36	0 11 S
	Venus . .		21 30	15 14 S
	Mercury .		22 20	12 37 S
15	Sun . . .		23 41	2 2 S
	Jupiter . .		6 7	23 33 N
	Em. 1 Sat.		9 29 or 9^h 56' M T. (78)	
	XII. 35 . .	8	12 9	7 55 S
	Moon . .		12 15	7 49 S
	22 Virg. .	5.6	12 25	8 29 S
	χ Virg. . .	6	12 30	7 2 S
	Mars . . .		12 35	0 4 S
	Venus . .		21 35	14 53 S
	Mercury .		22 26	12 8 S
16	Sun		23 45	1 38 S

Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time. H. M.	Planet's or Star's Declination. D. M.
	Jupiter . .		6 7	23 33 N
	Im. * . . .	7.8	8 36 or 8^h 59' M T.	
	*'s R.A. 13^h 4'		Decl. 12° 51' S. (10'S)	
	Em. . . .		9 36 or 9^h 58' M T. (5' N.)	
	Mars . . .		12 34	0 4 N
	XII. 262 .	6.7	12 57	13 58 S
	XIII. 19 .	7.8	13 4	12 32 S
	Moon . . .		13 11	13 44 S
	68 Virg.	5	13 17	11 47 S
	Mars . . .		14 47 + with γ Virginis.	
	Venus . .		21 40	14 32 S
	Mercury .		22 32	11 38 S
17	Sun		23 49	1 15 S
	Jupiter .		6 8	23 33 N
	Mars . .		12 32	0 12 N
	XIII. 190 .	7	13 38	18 22 S
	89 Virg. .	5.6	13 40	17 15 S
	XIII. 276 .	7.8	13 53	18 57 S
	Moon . . .		14 7	18 24 S
	Im. * . . .	7	14 31 or 14^h 49' M T.	
	*'s R.A. 14^h 8'		Decl. 19° 8' S. (16'S.)	
	Em. * . .		15 0 or 15^h 18' M T. (10's.)	
	Venus . .		21 44	14 11 S.
	Mercury .		22 38	11 5 S
18	Sun		23 52	0 51 S
	Jupiter . .		6 8	23 33 N
	Im. * . . .	7.8	11 46 or 12^h 0' M T.	
	*'s R.A. 14^h 59'		Decl. 22° 28' S. (15'S.)	
	Em.		12 3 or 12^h 17' M T. (12's.)	
	Mars . . .		12 31	0 19 N
	Venus . .		21 49	13 50 S
	Mercury .		22 44	10 31 S
19	Sun . . .		23 56	0 27 S
	Jupiter . .		6 8	23 33 N
	Mars . . .		12 30	0 27 N
	Im. * 1 . .	7	16 30 or 16^h 39' M T.	
	*'s R.A. 16^h 4'		Decl. 25° 1' S. (6'N.)	
	Im. * 2 . .	7.8	16 37 or 16^h 46' M T.	
	*'s R.A. 16^h 4'		Decl. 25° 1' S. (7'N.)	
	Em. * 1 .		17 31 or 17^h 40' M T. (16' N.)	
	Em. * 2 .		17 38 17^h 47' M T. (10' N.)	
	Venus . .		21 54	13 29 S
	Mercury .		22 50	9 58 S
20	Sun . . .		23 59	0 3 S
	Jupiter . .		6 9	23 33 N
	Mars . . .		12 28	0 35 N
	Venus . .		21 59	13 6 S
	Mercury .		22 56	9 22 S
21	Sun		0 3	0 20 N
	Jupiter . .		6 9	23 33 N
	Jupiter and II Gemini dif. Lat. 2'.			
	Mars . . .		12 27	0 48 N
	Venus . .		22 4	12 43 S
	Mercury .		23 2	8 45 S
22	Sun		0 7	0 44 N

MARCH.

Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time. H. M.	Planet's or Star's Declination. D. M.
	Jupiter . .		6 9	23 33 N
	Em. 1 Sat.		11 53 or 11h 51' MT. (85)	
	Mars . . .		12 26	0 51 N
	Venus . .		22 9	12 19 S
	Mercury .		23 7	8 9 S
23	Sun		0 10	1 8 N
	Jupiter . .		6 10	23 33 N
	Mars . . .		12 24	0 59 N
	Im. * . . .	8	15 7 or 15h 1' MT.	
	*'s R.A.	19h 36' Decl. 21° 56' S. (1' S.)		
	Em.		16 12 or 16h 6' MT. (6' s.)	
	Venus . .		22 13	11 56 S
	Mercury .		23 13	7 29 S
24	Sun		0 14	1 31 N
	Jupiter . .		6 10	23 33 N
	Mars . . .		12 23	1 7 N (Opp.)
	Venus . .		22 18	11 32 S
	Mercury .		23 20	6 49 S
25	Sun		0 18	1 55 N
	Jupiter . .		6 10	23 33 N
	Mars . . .		12 21	1 15 S
	Venus . .		22 23	11 9 S
	Mercury .		23 26	6 9 S
26	Sun . . .		0 21	2 18 N
	Jupiter . .		6 11	23 33 N
	Mars . . .		12 19	1 23 N
	Venus . .		22 28	10 44 S
	Mercury .		23 32	5 25 S
27	Sun		0 25	2 42 N
	Jupiter . .		6 11	23 33 N
	Mars . . .		12 18	1 31 N

Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time. H. M.	Planet's or Star's Declination. D. M.
	Venus . .		22 32	10 19 S
	Mercury .		23 39	4 41 S
28	Sun		0 29	3 5 N
	Jupiter . .		6 12	23 33 N
	Em. 2 Sat.		8 43 or 8h 19' MT (91)	
	Mars . . .		12 17	1 39 N
	Im. * 1 . .	7	17 6 or 16h 40' MT.	
	*'s R.A. 23h 26' Decl. 0° 21' N. (2' N.)			
	Em. * 1 .		17 35 or 17h 9' MT. (14' N.)	
	Im. * 2 . .	6	18 8 or 17h 42' MT.	
	*'s R.A. 23h 27' Decl. 1° 8' N. (14' S.)			
	Em. * 2 .		18 26 or 18h 0' MT. (10' s.)	
	Venus . .		22 37	9 54 S
	Mercury .		23 45	3 57 S
29	Sun		0 32	3 29 N
	Jupiter . .		6 12	23 33 N
	Mars . . .		12 15	1 46 N
	Venus . .		22 41	9 29 S
	Mercury .		23 52	3 10 S
30	Sun		0 36	3 52 N
	Jupiter . .		6 12	23 33 N
	Jupiter . .		10 38	and μ Gemini.
	Mars . . .		12 14	1 54
	Venus . .		22 46	9 4 S
	Mercury .		23 58	2 23 S
31	Sun . . .		0 39	4 15 N
	Jupiter . .		6 13	23 33 N
	Em. 1 Sat.		8 52 or 8h 15' MT. (94)	
	Mars . . .		12 12	2 1 N
	Venus . .		22 51	8 39 S
	Mercury .		0 5	1 36 S

Art. XV. *Proceedings of the Royal Society.*

The meetings of the Royal Society were resumed for the season on Thursday evening, the 20th of November, when the Croonian Lecture was read by Sir Everard Home, Bt., V.P.R.S. It consisted of observations on the Anatomy of the Human Brain, as compared with that of fishes, insects, and worms.

The Rev. Daniel Creswell, D.D., and John Bayley, Esq., were elected into the Society.

November 27.—A paper on the Migration of Birds, by the late Dr. Edward Jenner, was read. It was transmitted to the Society by his nephew, Mr. W. C. Jenner.

Anthony Mervin Story, Esq., was elected into the Society.

On Monday, December 1st, (St. Andrew's Day having fallen on a Sunday,) the Fellows of the Royal Society held their Anniversary at Somerset-House.—At 12 o'clock, when the President took the chair, there was a numerous attendance of the Fellows. The President began the business of the day, by reading the lists of the newly admitted, and deceased, members, and on the last occasion paid a tribute of respect to the memories of Dr. Jenner, Dr. Hutton, Dr. Baillie, and Colonel Lambton, by describing the characteristic labours, virtues, and talents of these eminent men.

He then proceeded to state the award of the council of the Copley Medal, to Mr. Pond, the Astronomer Royal, for his various communications, published in the *Transactions of the Royal Society.*

In a discourse which was received with the most profound attention by the Fellows, the President gave a view of the important labours which had been carried on in the Royal Observatory, since its foundation by Charles II., and which had led to the most important discoveries made in modern times in astronomical science. He entered into an animated panegyric of Flamstead, Halley, Bradley, and Maskelyne, and spoke of the glory arising to this country, from the immediate or ultimate results of their researches which, illustrated by, and throwing light upon, the mathematical laws of the motions of the heavenly bodies, developed by our own illustrious Newton and his school, have given to us the true knowledge of the system of the universe. He spoke of the benefits which had been conferred by the observations, made at Greenwich, on navigation and our maritime interests, repaying a hundred fold the liberal expenditure of government on this great national establishment.

In speaking of the labours of Mr. Pond, he mentioned that the two most important points of research to which he had directed his attention, were, the question of the parallax of the fixed stars, and observations which seem to show a considerable apparent southern motion of many of the principal fixed stars. Mr. Pond thinks there is no evidence of a sensible parallax. Dr. Brinkley, on the contrary, is of opinion that this parallax distinctly exists. "The Council of the Royal Society," said the President, "do not

mean in any manner by their award of the medal to express an opinion on this subject, for when two such observers differ, the question cannot be considered as settled:" and he paid the highest compliments to the profound mathematical knowledge, acuteness, accuracy of research, and extent of view, of Dr. Brinkley. Between his observations and those of the Astronomer Royal, the problem of parallax was now, he said, reduced within very narrow limits, but perhaps more perfect instruments and observations would be required for its complete solution.

On the supposed southern declination of the fixed stars, it is impossible, said the President, to form, at present, any correct judgment; such an important result can only be established by new observations, carried on for a great length of time, and confirmed by the experience of the best astronomers, in different countries.

He desired Mr. Pond to consider the medal as a mark of the respect of the Society for the zeal and ardour with which he had pursued astronomy, and as shewing their confidence in the general accuracy of his observations. He likewise requested him to regard it, as a pledge that future important labours were expected from him. He exhorted him to emulate the fame of his great predecessors, and to endeavour to transmit his name to posterity by similar monuments of utility and glory.

The Society then proceeded to the election of a Council and Officers, for the year ensuing, when the following Members of the old Council were re-elected.

Sir H. Davy, Bart.
W. T. Brande, Esq.
Samuel Goodenough, Lord Bishop of Carlisle.
Taylor Combe, Esq.
John Wilson Croker, Esq.
Davies Gilbert, Esq.
Charles Hatchett, Esq.
Sir Everard Home, Bart.
John Pond, Esq.
William Hyde Wollaston, M.D.
Thomas Young, M.D.

The following were chosen Members of the Council, out of the Society.

William Allen, Esq.
Major Thomas Colby.
James Ivory, Esq.
Sir James Mac Grigor, Knt.
William Marsden, Esq.
William George Maton, M.D.
Bernard Edward, Duke of Norfolk.
Edward Rudge, Esq.
William Sotheby, Esq.
Henry Warburton, Esq.

Officers for the ensuing Year.

PRESIDENT.—Sir H. Davy, Bart.
TREASURER.—Davies Gilbert, Esq.
SECRETARIES.—William Thomas Brande, Esq.
Taylor Combe, Esq.

Thursday, December 11.—A paper was communicated "on the Nature of the Acid and Saline matters usually existing in the Stomachs of Animals, by W. Prout, M.D." The object of this paper is to prove, that the free acid, which exists in the stomach, and which frequently is thrown up in cases of indigestion, is the *muriatic acid.*

M. Fourier and M. Vauquelin, of the Royal Academy of Sciences at Paris, were elected Foreign Members of the Royal Society.

Thursday, December 18. A paper was communicated by the Rev. B. Powell, entitled "an Experimental Inquiry respecting the supposed invisible heating effect beyond the red end of the prismatical spectrum."

A paper was read "on the North Polar distances of the principal Fixed Stars," by J. Brinkley, D.D., F.R.S.

A paper was also communicated by James Ivory, Esq., F.R.S., "On the figure requisite to maintain the equilibrium of a homogeneous fluid mass that revolves upon an axis."

The Society adjourned over the Christmas Vacation, to meet again on Thursday, Jan. 8.

Art. XVI. ANALYSIS OF SCIENTIFIC BOOKS.

I. *A Course of Lectures on Chemical Science, as delivered at the Surrey Institution, by* Goldsworthy Gurney. *London*, 1823, 8vo. pp. 310.

Our attention was originally called to this book, by the exorbitant and solemn praises bestowed upon it in the daily and weekly papers. The *Times* holds it up as a model of scientific composition; the *Morning Post* deliberately represents it as a never-sufficiently-to-be-valued collection of new and important truths; *John Bull* says "there is no extant work on chemical science so full of important investigations;" and the *Literary Museum* concludes a critical review of its merits, by asserting that "in more than one instance, much new matter is presented to us in the way of theory as well as of practice; and the experiments by which the lectures are illustrated, are in almost every case original." With such reiterated testimonials in favour of Mr. Gurney's "Lectures," we should hold ourselves remiss in passing them over without notice, and our readers might suspect us of prejudice and partiality, attached as we are, to another school of chemistry, were we to withhold the important information, which according to the highly respectable scientific authorities above quoted, has thus emanated from the Surrey Institution.

In respect to our author's *originality*, we confess we were something startled at finding some long and unacknowledged quotations in the introductory lecture from works which we happened lately to have perused; but our apprehensions were speedily relieved, by the tale unfolded in Lectures II and III. For instance: "Put," says Mr. Goldsworthy Gurney, "into a glass vessel, containing water, a few grains of sugar of lead, and stir them together with a glass *or other rod*, the water will soon become turbid in consequence of the sugar of lead *being insoluble in that fluid*, and simply a mixture of the particles with the water will take place; if the water be minutely examined, these particles may be seen floating in it, and they will ultimately, if left to themselves, fall to the bottom. If to this *milky* fluid be now added a few drops of aqua-fortis, it will instantly become perfectly clear and transparent, and now not the minutest portion of the lead can be perceived in it. In the first instance then, it was *only a mixture*, in the latter a perfect solution, because the combination of lead and aqua-fortis is soluble in water, *whereas the sugar of lead is not so.*" p. 39.

The insolubility of sugar of lead in water was to us a new fact, and as *Thomson's System*, and *Henry's Elements*, happened to be

lying on the table, we found upon referring to the former, that water takes up 0.27 parts of sugar of lead; and in the latter, this salt is represented as "almost equally soluble in hot and cold water, *viz.*, to about one-fourth the weight of the fluid." We hope Drs. Thomson and Henry will make a memorandum of this oversight and correct it in future editions.

A little further, in p. 46, we are told that crystals of alum exactly resemble those of natural quartz, whereas we had always ignorantly supposed that the former were octoëdra, and the latter six-sided prisms.

In the second lecture Mr. Gurney rectifies Dr. Wollaston's errors respecting the theory of crystallization, but as we *can* understand Dr. Wollaston, and *cannot* understand Mr. Gurney, we consider ourselves inadequate to discuss the question. The arguments enunciated in pages 59, 60, et seq. of our author's lecture in reference to this subject are doubtless novel and profound; that they are, to our humble capacity, unintelligible, arises doubtless from the want of his "moveable diagram," the place of which is very inadequately supplied by Mr. Scharf's immoveable lithography. With great regret, therefore, do we pass over the new facts "connected with general as well as with chemical science," and tending to explain effects "which have hitherto baffled the most ingenious inquiry," set forth in this and in the succeeding lecture. We must leave the atoms "to seize their previous partners," or let them alone as they think fit, since our downright dulness prohibits our officiating as masters of the ceremonies upon the occasion.

Our ignorance also obliges us to decline any attempt at imparting to our readers the contents of Lecture IV, on chemical affinity, which if we mistake not, Mr. Gurney refers to the same laws as those which govern "musical vibrations;" when, therefore, he talks of vibration of sound combining three to two, and five to three, constituting thirds and great sixths; of tone being produced by a series of detonations, and detonations by the sudden formation and filling of a series of vacuums; of the definite divisions of the organ pipe, and the concords of the French-horn, the Æolian harp, and the musical glasses; and lastly, when we are informed that musical and chemical combinations depend on the same "regulations," that modulation is an imitation of definite proportions, and that in respect to time, every different note in the scale of music, is a simple multiple or division of the other, we unwillingly feel ourselves obliged to resign our critical labours as connected with this individual lecture, and to leave the decision upon its value and merits, to those who have more music in their souls, since our own attainments in that delightful art never exceeded the performance of the obligato part upon comb and paper, or an occasional *fantasia* upon the jews' harp. Thus much in candour to Mr. Gurney.

In Lecture V, we had hoped to have met him upon more equal grounds, but to our utter dismay, a few paragraphs brought us to a large organ, which our author undertook to build "some years since, when a very young man," and which was "admitted on all hands, to have a remarkably fine tone," though built "on theory, for I had never seen the interior of one, till I had finished mine, and knew nothing whatever practically of the construction of them." This organ was combined with a piano-forte, and together with the very pleasant anecdote brought in at p. 112, to which we refer our *musical* readers, is somehow or other intended to illustrate the doctrine of expansion, the strings of the piano being it seems expanded, and its notes flattened by heat, while those of the organ-pipes were affected in the opposite way.

At p. 119 of this lecture, we are informed that "*different* COLOURS *have different conducting powers in respect to heat;*" "*black conducts it the most readily, white the least so.*" This is quite new to us; so also are the following assertions (p. 121.) "Water, *unlike all other substances*, is of a greater specific gravity when in a liquid than in a solid state, which accounts for the lower parts of our rivers never being frozen." Again,—"The particles of water, previously to their assuming the state of a solid, conform to the general law of liquids increasing in specific gravity, as they lose their caloric." This gross error is the foundation of the blunders that abound in several succeeding paragraphs.

In the lecture on electricity, we are told at p. 133, that flannel becomes positively electrical when rubbed on glass, but negative when rubbed on sealing-wax, whereas the reverse is the case. We are also told that the contact of two different metals excites electricity *in an eminent degree;* that this electricity is increased by inducing a rapid change of surface, which may be effected by the action of an acid on the metals; and that it is necessary that the solution employed, be a good conductor of electricity. This is a very summary theory of the pile; and the difference between its phenomena and those of the common electrical machine, is equally hastily despatched. "In fact," says Mr. G., "the common electrical machine differs from the galvanic battery, simply from its being defective in physical power, if we may so express ourselves." At p. 136, we are informed that the decomposing powers of electricity were first pointed out by Sir Anthony Carlisle.

"Another property of electricity," says our author, "is that whenever the connexion is made between the two poles of a battery by a good conductor, it passes silently and without any visible effect." Now in the preceding paragraph, we have just learned that the said connecting wire is magnetic, and we suspect that we have sometimes seen it red-hot, and sometimes fused. But

the per-oration of this lecture is truly delectable, and we regret, we can only find room for an abstract of it, in which, however, we shall use Mr. Goldsworthy Gurney's own words.

"I cannot avoid coming to the conclusion in my own mind, that the regularity, the beauty, and the harmony, of all the changes which take place in the material world will, one day or other, be found to depend on the one grand disposing cause of electricity." And again, after observing that the functions of animals are dependant upon chemical changes, "I expect," he says, "it will not be long before it will be as universally admitted, that those chemical changes are brought about by electrical causes."

"That organic matter has some influence on the mind, cannot for a moment be doubted, and that the stomach is the chief source of this influence seems equally certain. Further it is well known, that a sympathy of the most intimate nature exists between the skin and the stomach. Now, holding, as I do, that all organic changes are in some way or other dependant on electrical agency, and that that agency is mainly available to us by means of the atmosphere, which serves as a conductor of electricity between the clouds to the earth and the human body, can it be considered as too fanciful a supposition, if I attribute the various changes of state in the human temperament, especially in persons of a nervous and irritable habit of body, to corresponding changes in the electrical state of the surrounding media, such as the earth and the atmosphere?" pp. 142, 143.

Now without meaning any disrespect to our author, we must beg leave to set this down as an unequivocal sample of that figure of speech usually called nonsense; and he should remember that much may be said in a lecture, and even plausibly urged in the warmth of argument, which will not bear to be printed and published.

We have of late heard a great deal of talk respecting the temperature of mines, and the evidence thus afforded of a source of heat within the earth; upon this subject we have always been sceptical; and rather than adopt the preposterous Beccherian notion of a central fire, have contented ourselves with viewing the phenomena as dependant partly upon the increased density of the air and its consequent diminished capacity for heat, at great depths, and partly upon other more obvious causes; but Mr. Gurney in his lecture on combustion, has set us right upon this head. "Combustion is one of those grand operations which are constantly going on within the bowels of the earth, where it serves the important purposes of composing and decomposing an immense variety of substances necessary to the renovations and revolutions which are perpetually going on among all organic as well as inorganic matter." p. 151.

In this same lecture we learn, at the bottom of p. 154, that it is impossible to make a room air-tight, and that health is injured in exact proportion as we do it; but a few lines further on we are told, that if the room be heated by flues, it may *safely* be made air-tight!

At pages 156 and 157, there are some sharp remarks upon Sir H. Davy's experiments respecting the temperature of flame, which according to Mr. Gurney, involve much contradictory evidence. Now as we have unfortunately not profited by Mr. Gurney's tuition, but happen to have received part of our chemical education under the former master; and as we belong to a school, one object of which is to teach his doctrines, and set forth his discoveries, we cannot be supposed to come unprejudiced to the consideration of our author's views, and therefore leave the determination of this subject to less biassed judges, observing at the same time, that we have looked in vain for those interesting discoveries which Mr. G. tells us he has made (p. 163) relating to gaseous bodies.

Thus far we have exposed our author's methods of handling the higher departments of chemistry; we now descend to the more immediate drudgery of the laboratory.

At p. 180, Mr. Gurney attributes to the "*upper sides*" of the leaves of plants, those functions which chiefly belong to their lower, and generally unvarnished, surfaces; and at p. 184, we find that "metallic oxides are generally reduced by the aid of *fluxes*, one of which is *carbon*," which in our conception of the term is no flux at all.

Speaking of the composition of water, it is stated to consist of 85 oxygen, 15 hydrogen; the proper numbers are 89 and 11. Nitrous oxide is said to contain 1 nitrogen and 2 oxygen by volume—those numbers should be reversed; and it is incautiously asserted that this gas may be breathed not only without injury, but often with benefit, for Mr. Southey, the Poet Laureate, declared that the sensations he experienced, were perfectly new and delightful!

In the 9th lecture we are informed that "it is *likely* that the Aurora Borealis consists of hydrogen gas, sustained at a certain elevation in the air, in virtue of its lightness, and ignited from time to time by electricity. The ignis fatuus also consists chiefly of hydrogen, in combination with phosphorus, generated by the decomposition of vegetable matter, and lighted by the heat given out during the act of decomposition," all which to our obtuse understandings, appears very *unlikely*, though the reasoning if not brilliant is at least luminous.

A little further on we are told, that the air emitted from the lungs consists of nitrogen and carbonic acid, and that as soon as it escapes from the mouth, the nitrogen ascends, and the carbonic acid descends, "thus preventing all danger of our again taking in

what was breathed out, precisely because it was unfit to benefit and sustain our animal functions." Yet in the same lecture Mr. Gurney dwells upon the "quality of permanently-elastic fluids of *interfusing* themselves equally amongst each other, when they are in contact."

Our chemical readers are probably aware that the nature of nitrogen is a problem which has attracted the attention of almost all eminent chemists, they will therefore naturally be anxious to learn Mr. Gurney's notions on the subject which are thus modestly set forth.

"Nitrogen I suspect, is a peculiar compound, formed by the organs of the animal body, and not a simple element as is generally supposed." "Under strong suspicion that nitrogen is a compound, and not a simple element, I am now prosecuting a series of experiments with a view of satisfying my mind upon this subject;" "and from the experiments I have already made, I am disposed to believe that it is not a simple substance, but a compound of oxygen, and hydrogen nearly in equal proportions." p. 202.

But this lecture teems with novelties, for at p. 204, we find to our infinite satisfaction and surprise, that "charcoal contains 64 parts of pure carbon united to 36 parts of oxygen in every 100 parts," and "that it forms nearly the whole body of the vegetable kingdom," and "gives their peculiar character to those very rocks and cliffs, which form an impregnable barrier round the island which we inhabit, and render it inaccessible to the inroads of any foreign enemy, or even of the ocean itself."

By this time, any moderate reader will be satisfied with the "novelties" offered by our author, under the heads of nitrogen and carbon; turn we therefore to phosphorus. Phosphorus, we are told, is exclusively an animal product, and is "generated, or at least makes its appearance during the conversion of vegetable and mineral into animal matter," and that it has "some mysterious connexion with animal life. In proof of this, it is found, that several animals possess the power of generating and giving forth this substance at will." The glow-worm, the fire-fly, *&c.*, are next cited as instances!

In the lecture on the metals, there is an uncommon scarcity of those blunders and mistatements, or *novelties*, as one of the writers above quoted calls them, which pervade the other discourses; yet there are a few interspersed, as for example: "Nitrate of silver is so powerful an antiseptic, that a single ounce of it dissolved in 1200 ounces of water, will preserve the water in a state of purity *for ever!* The nitrate of silver is deleterious in its effects on the animal system; but when the water thus preserved is needed for use, the whole of the silver may be separated from it in a few minutes, by adding a small portion of muriate of soda or common salt," p. 217. In the same page, a compound of silver

and nitric acid is said to have uncommon fulminating powers; and further on, iridium, osmium, rhodium and palladium are represented as probably alloys of other metals, for this satisfactory reason, "since they are found no where but in the ore of platinum." At p. 220, it is affirmed, that the muriatic acid of commerce "always contains a portion of corrosive sublimate, *which is an oxide of mercury;*" and again, "mercury has a very strong affinity for gold, and may be seen to fix itself, and change the colour of this metal, even through the skin and apparel of those persons who have taken it to any extent; *this is a very common case in the West Indies where so much calomel is used!*"

In the lecture on acids and alcalis, there is a sad nomenclatural jumble at p. 234; and at p. 236, we find, that "what is sold as *soda water* ought to be simply pure water impregnated with this gas; but I am afraid this is very seldom the case." So are we.

Mr. Gurney is very unhappy in assigning to Dr. Priestley the due merits of his discoveries; he never mentions his name without coupling with it some unaccountable absurdity; our readers may take the following as a specimen. Speaking of Dr. P.'s experiments on the products of fermentation, he says, "the result of that inquiry was, the discovery of carbonic acid, which he called *dephlogisticated air.* This name was changed afterwards to *fixed air*, because it is found fixed in almost all vegetable substances." p. 236. Such a cluster of incongruities, it would be difficult to match.

Nitric acid is stated to be a compound of five to two—five of oxygen to two of nitrogen—five *what* of oxygen? two *what* of nitrogen? Here our author is evidently floundering amidst volumes and atoms.

To those who are desirous of a concentrated specimen of Mr. Gurney's eloquence, originality, and scientific acumen, we strenuously recommend the perusal of his twelfth lecture, from which we shall offer a very few extracts only.

After candidly telling his audience that he is now to occupy their time with conjectures and guesses, about which, he is himself, far from being satisfied or convinced, he observes that he feels no reluctance on this score, having had practice enough in experimental philosophy "myself," to know that the most brilliant discoveries, and the most important facts and theories, not only may arise out of happy guesses, but that the "most brilliant of these which we boast the possession of, have actually arisen out of those, rather than out of a direct course of study and experiment." Now, our limited experience conducts us to a diametrically opposite conclusion, and leads us to infer, that with the sweat of his brow, and the labour of his hands, man must earn his knowledge as well as his subsistence. As to the discoveries of his own, to which Mr. Gurney "himself alludes," we are as yet in dark ignorance,

unless that of the composition of nitrogen already before our readers, be alluded to.

Our author then touches upon moral philosophy, in which, he says, "as there is no beginning to our conjectures, there is no chance of their arriving at any end. If we begin to guess at all, as to the nature of moral causes, we may guess about them as much as we please; for there is no reason why we should ever stop. And in fact, about that which we actually know nothing, we never can, by any possibility, know any thing, except through the interpretation and revelation of a superior power," *&c.* Now all that we can possibly conclude from this passage is, that the latter part of it applies with singular fitness to Mr. Gurney's chemical knowledge.

But where so much "important matter of fact" is brought before us, we must not waste our space in these "shrewd conjectures and happy guesses," we therefore hasten to give our readers a spice of Mr. Gurney's notions, concerning "the effects of light in natural phenomena."

In the first place he tells us, that "light as well as heat is a modification of electricity," and that the various colours of plants are derived from metallic oxides, undergoing various changes, occasioned simply by their contact with light on the surface of the plant, and that during the night plants give out nitrogen. But all these "novelties" are trifling to those propounded by the truly original Mr. Gurney, in respect to animal functions. He asserts, and in sober seriousness too, that "the blood in animals contains iron and other metallic oxides, which not only occasions its particular colour, but determines its fitness for regulating the functions and renovating the powers of the system. Persons excluded from light become first pale and sallow, and finally sickly and diseased. Perhaps this may arise chiefly from the imperfect oxidation of the blood, occasioned by the absence of light." "Coloured bodies are all better conductors of heat than white, therefore animals clothed in white under the frigid zone, are better able to bear severe cold." At p. 262, et seq., there is abundance of analogous talk concerning "moonlight, the cheek of beauty, magnetism, sunshine, and electricity," which is offered with great diffidence, "because it is only lately that I have made the matter a subject of my thoughts."

But we must draw to a close. We have elsewhere complimented Mr. Gurney on his originality—his modesty induces him (p. 269,) to hope that he may allude to what he has said and done, as being with few exceptions novel and original, and may therefore meet with more indulgence than if he had pursued the common and beaten track; and finally, he concludes with the following peculiarly condescending and complacent paragraph.

"I would beg permission, also to refer to the new matter, in the way of theory, as well as of practical discovery, that I have been

led to offer to your notice, because it gives me an opportunity of stating publicly and unequivocally, that any good which may result to science in general from those discoveries, as well as any credit or advantage that may accrue to me in after-life, from being the agent in these discoveries, is due to my connexion with this Institution, for I will frankly confess to you that but for that connexion, it is more than probable, I should never have been led to make them."

We must now take leave of Mr. Gurney and of our readers. We recommend the former to waste no more time in original researches—no more money in puffing his book; and before he again tries his hand at a course of lectures, to peruse Mrs. Marcet's "*Conversations*" and Parkes' *Catechism*.—The latter are respectfully informed, that Mr. Gurney's Course of Lectures is printed for Messrs. Whittaker, in Ave-Maria Lane, and may be had at all the Booksellers.

P. S. We had almost forgotten to mention, that a lecture on the blowpipe is appended to this volume. Its style, as we might expect, is rather more inflated than that of the preceding discourses, but in "novelties" it yields to none of them. Among other valuable and original suggestions, we here find a proposal for illuminating our theatres by the light emitted from quicklime, under the influence of what Mr. Gurney elsewhere calls the *Ox* hydrogen blowpipe.

II. *Supplement to the Comparative Estimate of the Mineral and Mosaical Geologies, relating chiefly to the geological Indications of the Phenomena of the Cave of Kirkdale. By the Author of the Comparative Estimate.*

The confidence which we expressed, in our review of Mr. Penn's *Comparative Estimate* that he would find little difficulty in reconciling the phenomena of the Kirkdale Cave with his geological interpretation of the Mosaic account of the creation, was not unfounded, and we are happy to find that he has anticipated our expectations, and laid his views before the public in the form of a supplement, without waiting till a second edition of the original volume shall be called for. Mr. Penn informs us in a prefatory note, that, "the following pages were first drawn up, with a view to the extension of the conclusion of chapter 6, part 3 of the *Comparative Estimate*, and to a new chapter immediately to succeed it," in a second edition, but in justice to the purchasers of the first, he has embodied the whole in the present supplemental volume. "The curious and important question to which it relates, could not have been anticipated in the first edition, as the work was printed before this new and interesting subject had been fully and distinctly brought before the world."

After the unqualified approbation which we have expressed in our 30th Number, of Mr. Buckland's *Reliquiæ Diluvianæ*, we shall hardly be suspected of any wish to undervalue that most able and interesting work, nor, from the equally decided commendation which we bestowed on the *Comparative Estimate*, in our 29th Number, can it be expected that we shall abandon our author, or hold his arguments for the strict and literal interpretation of the sacred text, by the united agencies of historical, moral, and physical evidence, in lighter estimation now than we did then.—On the contrary, the *Supplement* has strengthened our conviction of their force and justice, and proportionately exalted our opinion, high as it was before, of the talents and right-mindedness of the individual who urges them. Nor is this feeling at all incompatible with our admiration of the author of the *Reliquiæ Diluvianæ* and his delightful book, which for accuracy of observation, clearness, and minuteness of detail, stands unrivalled. But our object is not to draw a comparison between the two works, or the abilities of their respective authors, (for both we have the highest respect,) but to lay before our readers, as briefly as possible, the grounds on which Mr. Penn endeavours to shew the perfect accordance of the phenomena detailed in the *Reliquiæ Diluvianæ*, with the views he has promulgated in his *Comparative Estimate.*

It was suggested in that work, that the animal remains discovered buried *singly* in strata of gravel and clay, and those found in *multitudinous masses* in cavities of rocks, may very probably have resulted *from one and the same revolution in different localities*, and therefore that it is unnecessary, and unphilosophical to resort to different revolutions to account for the diversity. This suggestion, at which the time it was made, was founded on general probabilities, for want of more minute information, is now confirmed by the important and extensive means, recently supplied to us, of comparing the character and nature of the rocks, in which, in this and other countries, the innumerable mingled fragments of tropical animals occur, and which reveal to us the great geological fact, that all those rocks belong to one and the same class, *viz.*, limestone, whose texture and composition bear unequivocal evidence, by the intimate and multitudinous incorporation into their substances, of *marine organic remains*, that they were *not indurated, but soft and plastic*, when they rested in enormous masses, on the bed of the primitive ocean. "We may conclude," says D'Aubuisson, "from these *incorporated evidences*, that there are few facts in natural history established on such strong proofs as the aqueous fluidity of secondary soils, properly so called." Thus we recognise a period, in which the *substance of limestone* existed, not hard and consolidated above the waters, but soft and yielding within them. This idea of the original soft state of secondary limestone is strengthened by the analogous phenomenon mentioned by Saussure as "being daily exhibited by the sands on the border of the sea near Messina, which, though still

moveable when the waves accumulate them on the beach, gradually harden to such a degree as to serve for *millstones.*

To this soft bed, our author supposes the congregated masses of bodies of animals of all races and climates, confusedly crowded in close contact, to have been transported from the southward in a northerly direction, by the reflux current of the departing ocean, (as stated at length in the *Comparative Estimate,*) and to have been simultaneously deposited on, and finally immersed, by the turbulant vortices of the diminishing waters, in those parts of the then sea bed, which are now become Germany and England; "like the bodies of elephants and other animals, whose remains are found *separately* and *singly* plunged into beds of *clay.* Let us therefore endeavour to trace the probable and natural consequences of that vast and amazing operation, and let us observe to what *correspondence with the phenomena of the caves in question* they will conduct us."

Imprimis, the frame-work of the different animals would be shattered by the concussion they must have experienced during the transport, and at the moment of their immersion in the calcareous bed; and their skeletons, thus dislocated and fractured within their integuments, would be prepared to separate their parts, when the flesh and skins had decayed.

On the final departure of the sea, the soft mass would remain in its actual position, together with the substances it enclosed, and at length become indurated secondary rock, and it would be stratified, in consequence of the successive cumulations, at different intervals, of the plastic matter from which it was derived, and the strata would form regular horizontal planes, because they were deposited from suspension in a fluid.

As the mass dried, the foreign matter enclosed in it would be more or less detached from its substance, and left in a *nidus or cavity*, the size of which would depend partly on the original quantity and bulk of the foreign matter, partly on the degree of resistance it was capable of opposing to the contracting mass, partly on the expansive force of the gases arising from its putrefactive fermentation, and partly on the degree of compression to which, from various causes, it had been subjected; and from the last cause, always considerable, the already dislocated and fractured bones, must probably have been still more crushed and splintered, and the whole reduced within a much smaller space than it at first occupied. The fluid discharged by the drying and hardening rock, percolating through the limestone, would form stalactites, depending from the roof; the more copious droppings would keep the slime or mud which entered with the carcasses, for a long time in a liquid state, and that portion which drained down the sides and flowed to the bottom of the cavity, would form a solid floor of calcareous stalagmite, beneath the mud; whilst what fell directly

from above, would shoot out in branches of similar stalagmite, in striving to percolate downwards through it; or, if the mud were firm enough to support it, would form a crust on its surface. In the mean time, the animal substances, occupying the interior of the cave, would continually diminish by decomposition, and having been defended by their integuments from *rolling* or *trituration* during their transport, and from the time of their first immersion, such portions as had not decayed and perished, would necessarily exhibit surfaces wholly *untriturated*; moreover, because all the bodies were immersed *simultaneously*, in one vast united mass, no alternations of animal and mineral matter could have taken place.

Crevices and fissures in cavities lying near the surface would naturally be produced by the drying of a mineral paste saturated with water, and suddenly and permanently exposed to the action of air and heat; or, if the enclosed bodies were in very large numbers, the gases evolved by their decomposition might have distended the soil of the sides whilst yet soft and yielding, and even have forced their way through the weakest part, so as to form channels and orifices bearing no geometrical proportion to the original bulk of the bodies themselves.

"This operation, and its general effect upon the bodies, would only be a *vast enlargement* of that which we so commonly witness on a *minute scale*, in limestone rocks containing shells. In those rocks, in consequence of a similar process of exsiccation producing contraction and compression of the mineral mass, we sometimes observe the shells to be broken, sometimes altogether crushed, and sometimes again entire and freely moveable within their little cavities; and we often perceive the sides of those cavities to be coated with small crystals produced by the filtered fluid, as in the large cavities by stalactite. Now 'that which is so readily imagined on a *small* scale,' observes justly Dr. Mac Culloch, 'is as easily transfered to a *larger*; since, in the operations of nature *these terms are of no moment**.' We obtain, therefore, from what has been here exposed, a strong philosophical probability that the accumulated and mingled masses, of tropical and other animals, whose bony fragments have been found in Germany and in England, assembled in vast congeries in the interior of one and the same class of secondary rocks; containing also in their substances, in numberless instances, fragments of shells and other marine organic remains; were there enveloped, after transportation and deposition, *by the substance of the rock during its pristine state of fluidity in the bottom of the primitive sea*; just as the *shell* was unquestionably involved by the same substance *during its pristine state of fluidity*, and in no other manner; that the *cavity* in which they are found, was originally moulded upon the general surface of the aggregated

* *Geological Description of the Western Islands of Scotland*, vol. ii. p. 10.

mass, as the *nidus* of the shell was unquestionably moulded upon its surface; and that the *orifices* and *channels* in the rock, which communicate with those internal cavities, were produced by one, or other, or all, of the causes which have been described."

The phenomena of the cave at Kirkdale, (which are too well known to our readers to require that we should detail them in this place,) appear to have been produced by such operations on the large scale, but very different are the deductions which the eloquent professor of mineralogy (as Mr. Penn justly styles the author of the *Reliquiæ Diluvianæ*) has drawn from them. According to the hypothesis which he has framed to account for the phenomena, (which, at the outset, he observes, "seem calculated to throw an important light on the state of our planet at a period antecedent to the last great convulsion which has affected its surface," and "that they afford one of the most satisfactory chains of consistent circumstantial evidence that he has ever met with in the course of his geological investigation;") the limestone existed in its present consolidated state, and with its present cavity, at the time when the animals, whose exuviæ were found there, were lodged within it—and from the disproportion between the dimensions of the orifice of the cave, and the natural bulk of the larger animals, (elephant and rhinoceros.) he infers that they must have been introduced by the exertion of some of the smaller, *viz.*, the hyænas, either by individual industry, or "acting conjointly with others, piece-meal and by fragments, into the small recesses in which they are found." "The more rational idea," (more rational than the fanciful causes hitherto assigned to similar animal phenomena) "that the fossil exuviæ were drifted northwards by the diluvial waters from tropical regions," says Mr. Buckland, "must be abandoned on the authority afforded by the den at Kirkdale; and it now remains only to admit, that the animals must have inhabited the countries in which their bones are found *." The cave in question he therefore considers to have been the habitation, during a long succession of years, of a colony of hyænas, who dragged into its recesses the other animal bodies, "whose remains are found mixed indiscriminately with their own;" the probability of which idea he contends is supported by the comminuted state and apparently gnawed condition of the bones, and he adds, "this conjecture is rendered almost certain by the discovery I made of many small balls, of the solid calcareous excrement of an animal that had fed on bones, resembling the substance known in the old *Materia Medica*, by the name of *album græcum* †," and which the keeper of the menagerie at Exeter Change, immediately recognised, as resembling, in form and appearance, the fæces of the Cape hyæna. "I do not know," continues the Professor, "what more conclusive evidence than this can be added to the facts already

* *Reliquiæ Diluvianæ*, p. 173. † *Ibid.*, p. 20.

enumerated to show that the hyænas inhabited this cave, and were the agents by which the teeth and bones of the other animals were there collected *." On these inferences, Mr. Penn remarks, "thus that most complete and satisfactory chain of consistent circumstantial evidence, stated in the first instance, does not appear to connect any thing more than the *general conclusion* that the animals *lived* in Yorkshire, with the *premises* that their remains are now *found* there;" and he compares the *process* by which those inferences are obtained, to that by which the mineral geology, peremptorily inferred from the spherical figure of the earth that "*it really was once fluid* †."

Our author then proceeds to adduce several insurmountable objections, to which he contends that the hypothesis of the hyæna's den is liable, which we shall briefly recapitulate.

1. It has omitted to inquire whether the carcasses of those animals being *moveable bodies*, might not have been removed to their actual stations? Whether any power *capable* of removing them exists in nature? Whether such power has ever been brought into actual operation?

2. The cave at Kirkdale contains innumerable bones, not only of the larger quadrupeds, but also of *water rats;* all of which animals were, by the hypothesis, imported by the hyænas for the purposes of food. Now the bones of the larger animals resisted the teeth of the hyænas, and were only *gnawed*, by them; but the same cannot be argued of the innumerable bones of *water rats* which equally remains. "The presence of their minute and masticable bones, therefore refutes the cause assigned for the presence of the large and unmasticable bones, for no one would conclude that the hyænas spared the bones of rats, merely because they could not masticate those of elephants. Certainly not, replies the hypothesis, 'but in masticating the bodies of these small animals with their coarse conical teeth, many bones, and fragments of bones, would be *pressed outwards through their lips,* and fall *neglected* to the ground ‡'.

"This retort is indeed quite unexpected; yet surely, if we ever witnessed the fate of a mouse in a cat's mouth, we are perfectly competent to judge whether so small and friable a mouthful as the body of a *water rat* within the jaws of a hungry *hyæna,* would be likely, notwithstanding the coarse conical teeth of the latter, to eject any bones or fragments of bones to testify of its fate;" and even if it did, Mr. Penn insists on the improbability that they should have *remained neglected*, in the presence of so many hyænas, young and old, as the hypothesis assumes to have co-existed in the cave, taking into the account the excessive greediness for bones, which the hypothesis tells us they are remarkable for.

* *Reliquiæ Diluvianæ*, p. 21. † *Comparative Estimate*, p. 34, *&c*.

‡ *Reliquiæ Diluvianæ*, p. 34.

"The hypothesis, moreover, asks, 'if bears eat mice, why should not hyænas eat rats?' I know no reason why they should not; but if they are so peculiarly fond of bones, and yet so awkward as to drop them in the actual eating, it is most probable they would have gratified their natural propensity as soon as they felt the calls of hunger return, instead of neglecting them, and that they would thus have converted them into a *much more proportionate quantity of album græcum*, than appears by the report to have been discovered in the cave." The hyæna's fondness for bones, therefore, becomes a "strong presumptive evidence that this rich treasury of bones of all magnitudes was never in the power of a confraternity of hyænas '*whose* habit it is to devour the bones of their prey *.'"

3. Our author questions the certainty that the small balls, called *album græcum*, were really the excrement of the hyæna, and supposes they may have been merely accidental conglobations of the sediment in the cave, which is stated to have consisted of a *soft mud, or loam, mixed with much calcareous matter, which seems to be derived, in part, from comminuted bones* †. This strikes us as the weakest part of our author's objections to the hypothesis, and we think he must have forgotten that the album græcum was submitted to analysis by Dr. Wollaston, "who found it to be composed of the ingredients that might be expected in fæcal matter derived from bones, *viz.*, phosphate of lime, carbonate of lime, and a very small proportion of the triple phosphate of ammonia and magnesia ‡." No mention is made of the presence of *alumina* which must have been found in them had the balls been formed of the sediment of the cave, the substance of which is said to have been an *argillaceous* and slightly micaceous loam §, mixed with the calcareous matter, *&c.* The conjecture with which Mr. Penn concludes this head, is more forcible; "if the animal fæces *could have remained in the cave undissolved by the diluvial waters*, which the hypothesis supposes to have *occupied it during the period of their continuance on the earth*, an *accumulation of the same substance* would probably have been discovered *underneath the diluvial mud*, answering by proportion to the number of those inhabitants in their succeeding generations, and to the duration of their tenancy; which does not appear to be the case from the terms of the report."

4. The supposed marks of hyænas' teeth on the larger bones, Mr. Penn very rationally conceives may be attributed to a variety of totally different causes, and very justly exclaims, "it is too much to call upon us in this period of the world to acknowledge the remarks on antediluvian bones found in Yorkshire, for evidences of

* *Reliquiæ Diluvianæ*, p. 37. † *Ibid.*, p. 10. ‡ *Ibid.*, p. 20. § *Ibid.*, p. 10.

hyænas' teeth, and to make the *truth* of *geology* to depend absolutely upon *that acknowledgment*."

5. The finding, in a German cave, of the "bones of a bear, so small that it must have died immediately after its birth," is no *proof*, as the hypothesis contends, "that animals lived and died through successive generations in the cave in which we find their remains," for since the diluvial waters swept away at once an entire animal creation, of all ages and generations, where we find the exuviæ of the *old*, we shall expect to find the exuviæ of the *young* also, "and then the remains of a *hyæna cub* in England, or a *bear cub* in Germany, will no more testify to their having been *born* in those countries, or to their parents and progenitors having lived and died in them, than the remains of a drowned *puppy* on the beach, or in the drain to which the flux of the tide may have driven it."

6. Our author contends that the popular tales collected by Busbequius (quoted at p. 22, of the *Reliquiæ Diluvianæ*,) cannot lay claim to much authority at the present day, and that it does not appear from natural history that it is the custom of hyænas, and other beasts of prey, to convey their booty to a den, "*and that always the same den*," and there to devour it. On the contrary, natural history informs us, that lions, and other carnivorous animals ravenously devour their food on the spot where they seize it, leaving behind them what they do not immediately consume; and Campbell says*, that these *remnants* form a considerable part of the food collected by the Africans during the period called the Bushman's harvest. Mr. Penn concludes, therefore, "that the hyæna's den of the hypothesis had never any more relation to reality and fact, than the lion's den of ancient Æsop;" that those animals eat *bones* only when they cannot get flesh, and that if "the violence of the diluvial waters" has swept away the heaps of bones which Busbequius asserts the modern hyænas of his day collected *round* their dens, and which, consequently, cannot now be shown, "it is only the more necessary that the hypothesis should show us the *inside* bones of the dens of modern hyænas."

7. He denies that natural history supports the assertion that hyænas divide large carcasses into small portions in order to convey them through a small orifice, either by individual labour, "or acting conjointly with others."

"But that which constitutes the most weighty and really important objection to this ingeniously inventive *hypothesis*, is its direct contradiction of the philosophical conclusions of the Mosaical geology, whilst it is unprovided with any counter principles, deduced from that or any other geology, of virtue to invalidate those conclusions." The hypothesis is founded on the

* *Travels in South Africa*, vol. ii. p. 19, 20.

superficies of present and sensible phenomena, and seems afraid of venturing to ascend to the principles which generated them. "The *Reliquiæ Diluvianæ* has indeed ably and unanswerably added to the demonstrations of the truth of the sacred history of a deluge; not by hypotheses of hyænas' dens, but by its sagacious discrimination between *alluvial* and *diluvial* productions; and by its enforcement of the amazing proofs of inundation *at high levels*;" and the conviction we thus obtain of the truth and consistency of the sacred historian in this respect, stimulates us to seek the same character in his history of every thing which preceded that event, up to the hour of creation.

By combining the history, given us by Moses, of the creation, with his history of the destruction of the former earth, and by comparing both with the actual phenomena of our globe, "we have found the most powerful evidences conspire to substantiate the *transport* of the dead bodies of a former animal creation, from the tropics towards the poles," but none to support the supposition of the hypothesis, that animal genera, now confined to the tropics, once inhabited northern Europe; none that the relations of the sun and the circles of the earth have ever so much varied as to produce the climate of the torrid zone in the polar vicinities of the temperate, essential to that supposition. In short, the point at issue resolves itself into this question; "Whether the exuviæ went to a polar climate, or a polar climate has come to the exuviæ."

Buffon supposed our earth to be a bit of the sun knocked off by a blundering comet, and that it gradually cooled as it passed through space; "the eminent author of the hypothesis of the hyæna's den" cautiously abstains "from committing himself by any opinion as to what the cause of the change of climate was;" nevertheless he decidedly thinks that the presence of the remains of tropical animals at Kirkdale, proves them to have been antediluvian inhabitants of Britain, and that, therefore, the northern latitudes were probably warmer before the deluge, than they are at the present day. The direct contrary to this is asserted and supported by Daines Barrington*, who says, "that the seasons have become infinitely more mild in the northern latitudes than they were sixteen or seventeen centuries ago;" and the Abbé Mau concludes from numerous testimonies that all the countries from Spain to the Indies, and from Mount Atlas to Lapland, have passed from extreme humidity and cold to a great degree of dryness and warmth†.

* *Philosophical Transactions* for January 18, 1768.

† Memoires sur les grandes gélées, &c.

The increasing temperature as we descend into deep mines, has lately been adduced as an argument in favour of the hypothesis of the gradually diminishing heat of the earth. The following solution of the phenomenon

This must be so if our earth was the former sea bed, but if its surface was merely covered by the diluvian waters, for about twelve months, though they might for a time have caused a lower temperature than prevailed in it prior to the deluge, yet it would eventually recover, on drying, its original temperature, but by no means become *hotter* than before. Thus, to whatever period we refer, we find the climate of Siberia or Yorkshire equally unadapted, as at the present day, for elephants, hyænas, *&c.*, to have lived in them, and "that discovery becomes collateral demonstration, that the animals, whose remains are found in them, did not arrive there in a state of *life*, but of *death*, and therefore at the period and by the means which we have been enabled to investigate and assign."

In the German cave mentioned by Cuvier, scarcely any exuviæ of graminivorous animals were found; their contents consisted chiefly of the bones of bears, mixed with those of the hyæna, wolf, fox, tiger, *&c.* The difference between these animal associations and those of the Kirkdale cave, sufficiently indicates them all to have been as fortuitous as those in the Val d'Arno confessedly are; and although the hypothesis would account for the absence of graminivora, by supposing the bears to have preferred vegetable to animal food, the attempt cannot explain why they are associated

has been proposed by Mr. Miller. (*Trans. Wern. Soc.* vol. iv. part 2; and *Annals of Philosophy, New Series*, vol vi.

The system of ventilation adopted in mines, causes a current of air to descend from the surface, and to traverse the deepest workings, and afterwards to ascend. The air thus sent to the bottom is necessarily *condensed* in proportion to the depth of the mine, and from its diminished capacity for heat, has its temperature proportionately elevated. "The air, thus heated, traverses the works, and imparts its heat to the strata, it then ascends, and is succeeded by a fresh portion of air from the surface, which in the same way becomes heated, and imparts its heat to the strata, and they, in turn, communicate it all around. Thus in a long course of working in a deep mine, the air at the bottom is heated, and also the rocks to a considerable depth; and when the working ceases, the mine takes a long time to lose its temperature; and this is found to be the case, particularly when the mine becomes full of water, the water being found at first of a high temperature, and gradually to lose its heat, which is in consequence of the strata imparting theirs to the water, and as soon as they have given out all their heat, the water indicates the mean temperature nearly of the place.

"The reverse takes place in an old mine when re-worked; in that case, the temperature rises gradually as the working continues; and in those mines which are not worked, but in which the ventilation still goes on, I believe it will be found that they do not lose more of their temperature than can be placed to the abstraction of the other causes of heat in working mines, such as that produced by the men and the lights.

"The exact quantity of heat given out by air in proportion to its condensation, it is difficult to ascertain, but every day's experience proves it to be very considerable; and, I believe, this, added to the other obvious sources of heat in mines in a state of working, will be found sufficient to account for their high temperature."——

We believe so too.

in the same cave with hyænas and other carnivorous animals. But these German bones are never rolled or triturated, and therefore cannot have been brought from a distance by the waters. But water can *carry on its surface* as well as *drive along its channel*; and bodies can be moved before, as well as after they are reduced to skeletons.

We may add, that if naked skeletons had been transported by being driven along by the waters over the bed of the tumultuous ocean, it is hardly possible, but that all of them must have been crumbled to dust before they could have travelled to any considerable distance. In short, comparing all the evidence, we may safely conclude, that "the same cause that floated from a southern latitude the *solitary alligator*, found within the limestone rock in Dorsetshire, floated also, from the same quarter, the *consociated elephants and hyænas*, found within a limestone rock in Yorkshire; and that the same operation that kneaded shells into the limestone rocks of Portland, plunged both the *individual* and the *compound* body in the *limestone paste*, in whose *indurated* substances, they have at length been severally discovered:" and "the concentrating weight and contractile force of the limestone, while drying, settling, and consolidating its substance, appears completely to account at once, both for the narrow space into which the multitudinous exuviæ have become compressed, and for the necessary consequence of the bones, previously shattered and fractured in their transport, being more extensively and variously split and broken to pieces." And such is the state of the fossil remains in the close and solid strata of Paris, and so Cuvier accounts for them, without the agency of "hyænas to break them up in order to extract the brains and marrow."

For our author's answer to Mr. Buckland's conclusions that the phenomena of the Kirkdale Cave decisively establish the fact that the exuviæ of the animals found in it, were not driven northwards by diluvian currents from more equatorial regions, but that the animals themselves were inhabitants of antediluvian Britain;—that a probable change of climate in the northern hemisphere, seems to follow from this circumstance; as well as the other important consequence, that the present sea and land have not changed places, we must refer our readers to the *Supplement* itself, lest we should do injustice to its logical precision and force, by attempting to abridge it. From the same motive, we forbear to dwell on his reasoning, to shew that the vertical fissures, in the present surfaces of limestone rocks, together with their caverns, are necessarily post diluvian, with a great mass of powerful argument against the general geological inferences contained in the *Reliquiæ Diluvianæ*, and many minuter details from which those inferences are deduced.

The following passage, however, is too forcible to be omitted or

abridged. "Had the cave with all its actual attendant circumstances, occurred in a *primitive rock*, as *granite*, then, indeed, there would have been a wide field for conjecture, (as to how the bones got in,) and a heavy necessity for resorting to the invention of hypothesis to find a plausible solution of the difficulty; then indeed, we must perforce have conceded to him, (Professor Buckland,) his proposition, that the 'bones found within it, were lodged in the cavities which contain them, *at periods* long subsequent to the formation and consolidation of the strata in which the cavity occurs.' But as soon as it is thoroughly ascertained that the rock which encloses them is *not of primitive* but of *secondary formation*, bearing its own demonstration of *former fluidity in a sea bed;* as soon as it is farther ascertained that *all the rocks*, in whose interior similar acervations have been discovered, are of the *same secondary* formation; then we refuse to concede his proposition, because all reason for making the concession is taken away, and all necessity of resorting to the improbable anomaly, that tropical animals once *lived* in the northern regions where their bones are found, ceases at once."—"The *consolidation of the Kirkdale limestone subsequently to the introduction of the animals*, is therefore to be maintained on principles sounder, more simple, more probable, and more strongly attested, than any which have been or can be adduced to show, that *indigenous hyænas once quartered indigenous elephants in the North Riding of Yorkshire;* which nevertheless constitutes the *essence*, nay, the *very vital principle*, *of the hypothesis.*"

Having thus shewn that the phenomena altogether fail in proving, that the Kirkdale cave "was once a den inhabited by hyænas," on which authority alone, Professor Buckland considers that the "rational idea that the fossil exuviæ were driven northward by the diluvial waters from the tropical regions, can be disproved," our author concludes this part of the subject in the following words. "With this great question, thus previously solved and settled for our caution and guidance, with respect to the principles requisite for correctly reading, interpreting, and resolving the important geological phenomena described, we may securely take all the benefit of the wonderful and awful monument of diluvial power and destruction unveiled to us in the cave of Kirkdale by the energy of its active explorer; and all the enjoyment of the stores of antediluvian antiquity, which the *Reliquiæ Diluvianæ* has so liberally laid open to us, and for which our obligations are great indeed, to its pious, able, and attractive author."

The remaining pages of the *Supplement* are occupied by some masterly observations on the consistency of a *literal* interpretation of the terms in Scripture with philosophical inquiry—on the sufficiency of *two revolutions only* to account for all the actual phenomena of our earth, and the moral evidence that the six days of

creation are to be interpreted as six natural days, and not as so many periods of indefinite length.

The last passage we have quoted from our author, will serve to shew the gentlemanly tone he has assumed, and the respectful terms in which he speaks of Professor Buckland, whenever he has occasion to mention him personally—a respect most eminently his due, and in which with all our heart, we sincerely concur. A similar tone prevails throughout the whole work, and though the arguments with which Mr. Penn supports his own views, are strong and powerful, they are urged with mildness and urbanity. If they do not convince, they cannot offend.

But we must not in justice, either to our author, or ourselves, take leave of him with mere negative commendation. We think he has fully made out his case, and if any thing was wanting to satisfy us of the stability of the reasonings contained in the *Comparative Estimate*, and the accuracy of the conclusions deduced from them, they are in our opinion, amply supplied in the *Supplement* to this admirable work.

III. *Lectures on Comparative Anatomy, in which are explained the Preparations in the Hunterian Collection, illustrated by Engravings; to which is subjoined "Synopsis Systematis Regni Animalis nunc primum ex Ovi Modificationibus propositum,"* by SIR EVERARD HOME, Bart., V.P.R.S., F.S.A., F.L.S., &c.

In resuming an account of this splendid work, we must, as in the former article (p. 134), limit ourselves to its principal features only, selecting especially for our readers' notice the new facts which it embraces, and the new views which it discloses and illustrates.

In the first place, we cannot omit recording in our pages the extraordinary fact, first published by the author, of an animal, (the Dugong, in the Eastern Seas, and the Manatee in the great rivers of the Western Continent,) in which the heart is divided into two distinct portions of similar structure and equal force, the blood in its passage through the lungs requiring the same impetus as in passing through the different parts of the body. There is also a curious account of a nearly complete fossil skeleton, illustrated by engravings, which forms in itself, an important and distinct class of the antediluvian animals no longer met with on our globe. He gives it the name *Proteosaurus*, as the class to which it belongs is intermediate between the lizard and Proteus.

On the subject of generation, the author has taken particular pains, and has certainly been fortunate in his researches. The discovery of the human ovum appears to please him more than any

other he has made. In the lecture upon that subject, he expresses himself thus:—

"The discovery I am about to promulgate, was most undoubtedly the result of accident; but similar accidents have before occurred, without the discovery having been made, and now that the fact is established, there will not be wanting in every country of Europe, opportunities of confirming it. But without the aid of the microscropical observations of a Bauer, the fact even now, could not have been satisfactorily established, and with that assistance I have met with it a second time.

"That the professor of Comparative Anatomy to this college, should in his lectures be enabled to prove to demonstration the origin of the human fœtus, which the great Harvey, who gave lectures upon the same subject in the neighbouring College of Physicians, was unable to discover, must be gratifying to every one of our members."

The mode in which the discovery is detailed, is so clear and distinct, and at the same time so interesting to all who prosecute anatomical pursuits, that we shall indulge our readers with it.

"In this examination I was assisted by Mr. Clift: on observing accurately the right ovarium, there was upon the most prominent part of its external surface, a small jagged orifice; this induced me to make a longitudinal incision in a line close to this orifice, and a canal was found leading to a cavity filled with coagulated blood, surrounded by a narrow yellow margin, in the structure of which, the lines had a zigzag appearance.

"The cavity of the uterus was then opened, by making an incision through the coats from each angle, and where these met in the middle, a third incision was continued down through the os tincæ. The three angles were turned back, so as to expose the cavity, and the sides were gently separated from each other. The os tincæ was completely blocked up by a plug of mucus, so that nothing had escaped by that passage; the orifices leading to the fallopian tubes were both open, and the inner surface of the cavity of the uterus was composed of a beautiful efflorescence of coagulable lymph, resembling the most delicate moss. This efflorescence had fibres of a greater length on the posterior surface, a little way beyond the os tincæ than at any other part. Being certain that nothing could have escaped, I began gently shaking the efflorescent fibres with a needle point, and said to Mr Clift, that if we found any thing it would be in that part. During this examination, the whole of the uterus was immersed in spirit, and the needle point in its movements brought a small transparent body above the surface of the efflorescence of coagulable lymph, but it immediately sunk again; I raised it a second time, and saw distinctly that the moment it was exposed to the spirit, it became opaque; it had an

oval shape. I cried out, 'We have got it;' Mr. Clift less sanguine, and not seeing the change of colour, my eye being directly over the basin, believed it was only a little coagulated lymph. Perfectly satisfied that I had got the ovum, I went immediately to Mr. Bauer, that he might submit it to the test of the microscope, and by this means, have the fact completely confirmed."

That all animals originate from an ovum, formed in the ovarium of the female, and afterwards impregnated, has been an opinion universally believed ever since the time of Harvey, but it is to our author, that we are indebted for the demonstrative proof of such an opinion; to him also is the merit due of having ascertained the real use of the corpus luteum, which before was not at all understood. He also has set to rest all the vague theories respecting generation, having by his experiments and observations, brought forward facts explanatory of all the occurrences, in the different stages of that most curious and wonderful operation.

The mode of breeding of the marsupial animals, in which the ovum never becomes attached to the uterus, and that of the ornithorhyncus which lays its eggs in the same manner as the bird, while they connect classes of animals together, in other respects so different from one another, will be found to be highly interesting to the philosopher, and indeed to all those who are admirers of the works of nature. That an animal should exist with so many remarkable peculiarities is so extraordinary, that some of the best anatomists of the present day, not having a conception that there could be such a construction of parts, and the specimens under their examination not being well preserved, entirely overlooked the fact. As we are not venturing to attempt more in this short article than to point out to our readers the most prominent facts which the author has laid before the public, we shall pass over what is said upon the breeding of cold-blooded animals, in which there are two sexes, and go at once to the account of those that impregnate themselves. And in this place we are ready to admit that there is a reason beyond those already given, that prevents us from venturing too far into these *terræ incognitæ* of science, lest we should commit ourselves, either on the one side in praising, or on the other in condemning opinions, because we ourselves do not understand them; we therefore, repeat here, that it will require the confirmation of future labourers in the wide field of comparative anatomy, to confirm or refute the statements given by the author.

That he was the first who had the opportunity of examining the internal structure of the Teredines, and shewing, that an animal of the same description was met with in India, of so gigantic a size as to exceed in an equal degree the Teredo Navalis, met with in our ships, as the Clamp of New South Wales does the common oyster, is fully established by his account many years ago in the

Philosophical Transactions, and, to him we also owe the discovery of its possessing both male and female organs, and that it both formed the ova in the ovarium, and afterwards impregnated them. Having established this mode of generation in the teredines, he found the lamprey, the common eel, and the conger, to be so many different tribes of self impregnating animals. His merit upon these subjects is, however, not all his own. He is indebted to Mr. Bauer and Mr. Clift for their exertions in making drawings illustrative of the facts he brings forward, and had he not been so assisted, many doubts would certainly have hung over a great part of his labours.

He has been the means of enabling Mr. Bauer to immortalize his name, by a series of drawings of internal parts of the earth worm, and the progress that takes place in the formation of the chick, during the process of incubation, which we may venture to say will probably never be excelled. That the first part formed in that process is the brain and spinal marrow; the heart, arteries, and the other parts, being all secondary, their structure not arising out of the molecule itself, but depending upon the supplies derived from the yelk and albumen, are so many original facts of the highest physiological importance.

So much for our account of this valuable work, which were there not one single word of letter press, would be a great accession to anatomical science, since it contains more than three hundred plates, by two such distinguished draftsmen as Bauer and Clift.

On the synopsis, which is subjoined, bringing forward a new scheme for the classification of animals, we must let the author speak for himself, before we venture upon any remarks of our own.

" Every step we advance in the acquirement of knowledge in comparative anatomy, makes us better acquainted with the defects that exist in the general systems at present before the public. The truth becomes obvious, of there being no organ belonging to an animal except the brain, that will bear us out in affording characters for a general classification, the structure of the other organs being varied whenever it was necessary to adapt the animal to the climate which it is to inhabit, or the food on which it is to subsist; and the brain we are not sufficiently acquainted with to take as our guide.—There is only one fixed principle that admits of being laid hold of for that purpose, without which the whole scheme of nature would have been thrown into confusion. The principle I allude to, is that which prevents animals differently constructed from breeding with one another at all, and does not allow those that are more nearly allied, to carry on the breed beyond one generation.—The ovula of plants was to botanists, what the molecule in the ovum of the human species and quadrupeds is to the anatomist; and till that knowledge was acquired, and the changes produced in it by impregnation, were

known, with the consequent process to be gone through, by which the molecule was to become an animated being, no attempt could be made by the most intelligent physiologist, not even by a Harvey or a Hunter, in former times, or a Cuvier in our own, to form the scheme of a general classification upon the principle which is now brought forward.

The idea of such a scheme originated in finding that the human ovum, and that of quadrupeds, consisted entirely of the molecule.

In the kangaroo, that this molecule at its origin, was under the same circumstances, but that an addition is made to it before it arrives at the uterus, and in that cavity it is furnished with albumen.

In the opossum of America, the molecule at its origin, has a yelk connected with it in the ovarium, and in the uterus is supplied with albumen.

In the ornithorhyncus the molecule has a yelk connected with it in the ovarium, receives albumen in the uterus, passes through the vagina, and at the cloacus is covered by a calcareous shell and passes out of the body before it is hatchd.

In the bird the molecule has a yelk connected with it in the ovarium, has a supply of albumen in the oviduct, and having no uterus, a shell is formed in the cloacus and the egg is hatched out of the body.

"So beautiful a series," as the author calls it, must naturally have made a strong impression upon his mind, bnt whether it will bear him out in forming a new system of the animal kingdom, or what time it will require to bring it to perfection, even if others who follow after him, should adopt it, which in these days of novelty is very problematical, are questions we are not called upon to answer, and we shall finish this article by an enumeration of the twelve classes, into which, according to this ne w stem animals are divided.

SYSTEMA,

REGNI ANIMALIS.

NUNC PRIMUM EX OVI MODIFICATIONIBUS PROPOSITUM.

Classes.

1. Echemetroa. Embryo ex ovo in corpore luteo formato evolutus in utero quocum adhæret.
2. Eamnetroa. Embryo ex ovo vel in corpore luteo vel in vitello formato, evolutus in utero a quo solutus.
3. Ecmetroa. Embryo ex ovo vitello instructo et in utero impregnato incubatione evolutus.
4. Exostoa. Embryo ex ovo vitello instructo et in oviducto impregnato, incubatione evolutus.

5. Enaerogenoa. Embryo ex ovo in oviducto impregnato, absque incubatione evolutus.
6. Amphibigenoa. Embryo ex ovo in ovario formato, instructus pulmonibus et branchiis nudis evolutus in aqua.
7. Enhydrogenoa. Embryo ex ovo in ovario formato, branchiis operculo tectis instructus evolutus in aqua.
8. Metamorphogenoa. Embryo ex ovo in ovario formato, subjectus metamorphosi, stigmatibus respirans.
9. Monogenoa. Embryo ex ovo a mare monorchide impregnato, branchiis instructus.
10. Hermaphoditogenoa. Embryo ex ovo hermaphroditi duplicis.
11. Autogenoa. Embryo ex ovo hermaphroditi unici.
12. Cryptogenoa. Embryones quorum primordia ignota.

IV. *Philosophical Transactions of the Royal Society of London, for the Year* MDCCCXXIII. Part I.

This part of the *Philosophical Transactions* contains twelve papers, illustrated by twenty engravings, the greater part of which are very creditably executed. The following are the titles and contents of the communications.

1. *The Croonian Lecture. Microscopical Observations on the Suspension of the Muscular Motions of the Vibrio Tritici. By* Francis Bauer, Esq., F.R.S.

The animalcule described in this paper, is the cause of that disease in wheat, called by farmers *ear-cockles* or *purples.* The diseased grains include a white globular matter, which, when put into water displays, in the field of the microscope, hundreds of minute worms in lively motion. As the water evaporates they dry up and are motionless, but become as lively as ever, when re-moistened, and this after a period of more than six years. By some ingenious experiments Mr. Bauer shows that the eggs of these vermiculi are conveyed into the plant by the circulating sap, and he succeeded in obtaining infected plants by inoculating healthy grains of wheat with portions of the vermicular globules. For the dimensions, aspects, and habits, of these worms we refer our readers to the author's paper, and to the two beautiful plates which illustrate it.

2. *On Metallic Titanium. By* W. H. Wollaston, M.D., V.P.R.S.

Certain small cubes occasionally observed in iron slag, had generally been regarded as pyritical, but upon minute inspection Dr. Wollaston observed, that neither their colour, crystallization, nor hardness, were those of pyrites. These crystals, purified from

iron by muriatic acid, were insoluble in muriatic, nitric, nitro-muriatic, and sulphuric acids. Infusible, but oxidated before the blowpipe, especially by the aid of nitre. Their perfect solution may be effected by the combined action of nitre and borax, since the latter dissolves the oxide as fast as it is formed, and presents a succession of clear surfaces, for fresh oxidation. But as these salts do not unite by fusion, the addition of soda, as a medium of union, shortens the process. The fused mass becomes opaque on cooling by the deposition of a white oxide, which may either be previously freed of the salts by boiling water, and then dissolved in muriatic acid, or the whole mass may at once be dissolved together.

In either case alkalies precipitate from the solution a white oxide, which is not soluble by excess of alkali, either pure or in a state of carbonate. By evaporating the muriatic solution of the oxide to dryness, at the heat of boiling water, it is freed of any redundant acid, and the muriate which remains is perfectly soluble in water, and in a state most favourable for exhibiting the characteristic properties of the metal. Infusion of galls gives the well known colour of gallate of titanium.—The colour occasioned by triple prussiate of potash is also red, differing from prussiate of copper, by inclining to orange instead of purple, while the colour of prussiate of uranium is rather brown than red.

Such experiments show in a concise and satisfactory manner that the small cubic crystals are titanium, in its metallic state, which is further proved by their being perfect conductors of very feeble electricity.

That titanium has no affinity for iron, seems evident from the situation in which the above crystals occur, and "it seems," says Dr. Wollaston, "equally indisposed to unite with every other metal that I have tried."

Its extreme infusibility renders it improbable that the cubes should have formed during cooling from a state of fusion; the author thinks it probable that they have received their successive increments by the reduction of the oxide dissolved in the slag around them; "a mode of formation," he observes, "to which we must have recourse for conceiving rightly the formation in nature of many other metallic crystals."

3. *On the Difference of Structure between the human Membrana Tympani and that of the Elephant.* *By* Sir Everard Home, Bt., V.P.R.S.

In man the drum of the ear is circular, and its muscular fibres form radii of equal lengths passing from the centre to the circumference; in the elephant it is oval and the muscular fibres are of unequal lengths, some being more than twice the length of others. The fine sensibility of the human ear to musical sounds,

depends, in the opinion of the author, upon the equality of the muscles of the tympanum.

4. *Corrections applied to the great Meridional Arc, extending from latitude 8° 9′ 38″.39, to latitude 18° 3′ 23″.64, to reduce it to the parliamentary standard. By* Lt. Col. W. Lambton, F.R.S., *&c.*

It appears from Capt. Kater's results that Col. Lambton's standard scale requires a multiplier of —,000018 to make it agree with Bird's standard; and that Ramsden's bar, used in the trigonometrical survey of Great Britain, requires the multiplier +,00007. That is to say, with respect to a measurement on the meridian the degree depending on Col. Lambton's brass scale must be multiplied by ,000018, and the product subtracted from the measure given by the scale, to reduce it to the parliamentary standard. And the degree depending on Ramsden's bar, must be multiplied by ,00007, and the product added to the measure given by the bar, to reduce it to the standard measure. The author then proceeds to correct the different sections of his arc by the above factors.

5. *On the Changes which have taken place in the Declination of some of the principal fixed Stars.* By John Pond, Esq., Astronomer Royal.

6. *Appendix to the preceding Paper—by the same.*

The mural circle having been pronounced by Mr. Troughton as perfect as when first erected, Mr. Pond resumes his observations, but finds the discordances which had so much perplexed him still continue. To place, however, the accuracy of the instrument beyond all doubt, he contrives an apparatus, which enables him to observe most of the stars by reflection, from the surface of Mercury; the result is, that several stars (and particularly those which had exhibited the greatest anomalies) thus observed, have within a fraction of a second, the same places assigned to them, as direct measurement from the pole had previously given them. Ten stars situated near the zenith, give the horizontal point of the instrument 123° 30′ 29″.54, whilst Sirius places at 123° 30′ 29″.47, differing only seven hundredths of a second. Hence, neither flexure of the telescope, or change of figure in the instrument, need be apprehended. The stars in which a very great deviation toward the South is found, are Capella, Procyon, and Sirius.

In the appendix to the above paper, Mr. Pond, finding that recent observations confirm the results hinted at in his last paper, investigates minutely how far the discordances between his present catalogue, and that of Bradley of 1756, and his own of 1813, may be accounted for, by instrumental error, or erroneous observation. The consequence of the inquiry is, that the present devia-

tion of the stars to the south of their predicted places, cannot originate either in the one, or the other—perceiving also that the extent of southern deviation, to which any star was liable, might better be predicted by a reference to its right ascension, than to its declination, Mr. Pond attributes the discordances to some natural cause. He observes, that instruments of well known celebrity, are said to give different results; claims no superiority for his own catalogue, from the circumstance of its being nearly a mean between those of Dr. Brinkley and Mr. Bessel, but considers each of the latter inaccurate, from flexure of the instruments, with which they were made—and states that his confidence in the accuracy of his present observations, and also in the superiority of the Greenwich circle over all others with the history of which he is acquainted, is derived from the coincidence in the results, obtained by direct and reflected vision, each at the same time giving to the instrument the same horizontal point.

7. *On the Parallax of α Lyræ.* By John Pond, Esq., Astronomer Royal.

The mural circle is here employed, to determine the difference of parallax, between γ Draconis and α Lyræ; and also the absolute parallax of the latter star—every care was taken, to equalize the temperature of the observatory with that of the outer air, and so nearly was this effected, that it became a matter of indifference, whether the observations were reduced by the employment of the interior or exterior thermometer—and the same results were obtained, whether two or six microscopes were used; (a circumstance strongly proving, that no cause of error need be expected from partial expansions of the limb of the instrument;) namely, that the angular distance between the two stars, measured in summer and winter, does not differ one tenth of a second—hence γ Draconis and α Lyræ have the same parallax, or their difference of parallax is = o.

Absolute Parallax of α Lyræ.

The observations to determine this, were made by reflection as well as by direct vision; equal pains were again taken to equalize the temperature of the inner with the outer air, and with the same success; the same results were procured, whether two or six microscopes were employed. They indicate that the sensible parallax of α Lyræ, cannot exceed a very small fraction of a second. The reason why Dr. Brinkley finds no parallax in γ Draconis, a small quantity in α Cygni, more in α Lyræ, &c., Mr. Pond attributes to the nature of his instrument, which as far as the zenith point is concerned, may be considered perfect, but which in proportion, as it is directed from the zenith, becomes less and less perfect. Mr. Pond concludes the paper thus: "The history of annual

parallax appears to me to be this: in proportion as instruments have been imperfect in their construction, they have misled observers into the belief of the existence of sensible parallax. This has happened in Italy, to astronomers of the very first reputation. The Dublin instrument is superior to any of a similar construction on the continent; and, accordingly, it shews a much less parallax than the Italian astronomers imagined they had detected. Conceiving that I have established beyond a doubt, that the Greenwich instrument approaches still nearer to perfection, I can come to no other conclusion, than that this is the reason why it discovers no parallax at all."

8. *Observations on the Heights of Places in the Trigonometrical Survey of Great Britain, and upon the Latitude of Arbury Hill. By* B. Beavan, Esq. *Communicated by* Sir H. Davy, Bt., P.R.S.

By levelling to the Grand Junction and other canals, the author found the country to the north of Arbury Station, suddenly to fall about four hundred feet, and to continue thus depressed for ten miles. Such a defect of matter induced him to suppose a southward deflection of the plumb-line, and by calculating the latitude of Arbury from that of Blenheim, as determined by previous observation, he found it five seconds less than shewn by the zenith sector.

9. *On some Fossil Bones discovered in Caverns in the Limestone Quarries of Oreston, by* J. Whidbey, Esq., F.R.S. *In a Letter addressed to* John Barrow, Esq., F.R.S. *To which is added a Description of the Bones. By* Mr. W. Clift, *Conservator of the Museum of the College of Surgeons.*

We owe to Mr. Whidbey the important geological fact of the existence of cavities containing bones, in the solid secondary limestone of Plymouth, which cavities exhibit no traces whatever of any external outlet. In his description of the cavern containing the bones of the rhinoceros, printed in the Philosophical Transactions for 1817, he particularly insists upon the uniform solidity of the surrounding rock. Sir E. Home tells us that Mr. Whidbey "saw no possibility of the cavern having had any external communication," and this singular and important circumstance is further verified as follows. "As in the contract for quarrying there are two prices, one for rock, and another for clay, earth, and rubbish, and two officers attend, one for the crown, and the other on the part of the contractors, who measure the contents of all caverns that contain clay or other soft materials, it is only necessary to mention that these officers state, *that the rock surrounding the cavern was equally*

hard with the other parts, requiring the same force to blast it, and that the quarrying was paid for accordingly." *Phil. Trans.* 1817. p. 177.

In the *Philosophical Transactions* for 1821, Mr. Whidbey describes some similar caverns, all surrounded by compact limestone rock, " none of which had the smallest appearance of ever having had any opening to the surface, or connexion with it whatever, or with each other;" he then goes on to say, that " many caverns have been met with in these quarries, the insides of which have been crusted with stalactite, but there was no appearance of this kind in the cavern were the bones were found, every part of it being perfectly dry, and nearly clear of rubbish; a circumstance which clearly proves it had no connexion with the surface, as in that case water would have found its way into it, the dropping of which would have formed stalactite as in other instances." *Phil. Trans.* 1821. p. 134.

In the present communication a cavern is described which, like the former, exhibits no evidence of any decided external communication or outlet, though the evidence to this point is perhaps not so satisfactory as that adduced in the former papers, to which we beg the particular attention of our geological readers, as importantly bearing upon Mr. Granville Penn's arguments noticed in a preceding article.

Mr. Clift has added to this communication a perspicuous description of the bones which are those of the bos, the deer, the horse, the hyæna, the wolf, and the fox. The bones formerly found were those of the rhinoceros, bear, and antelope.

10. *On the Chinese Year. By* J. F. Davis, Esq., F.R.S.

One of Mr. Davis's objects in this paper appears to be, to shew the folly of attributing any thing original in astronomical science to the Chinese, who were entirely ignorant of its objects and principles, before its introduction into their empire by the Arabians, and afterwards by the European missionaries. On this one subject, says the author, that singular nation has deviated from its established prejudices and maxims against introducing what is foreign,—they have even adopted the errors of European astronomy, for he discovered in a Chinese book, the exact representation of the Ptolemaic system,—he adds " indeed it is impossible not to smile at the idea of attributing any science to a people whose learned books are filled with such trumpery as the diagrams of Fo-hi, and a hundred other puerilities of the same kind." Mr. Davis offers several other proofs of the talent which the Chinese possess of stealing the discoveries of other nations and appropriating them to themselves.

The author proceeds to show that the Chinese have no solar

year, but that the Chinese year is in fact a lunar year, consisting of twelve months of twenty-nine and thirty days alternately, with the triennial intercalation of a thirteenth month to make it correspond more nearly with the sun's course.

11. *Experiments for ascertaining the Velocity of Sound at Madras in the East Indies. By* J. Goldingham, Esq., F.R.S.

This paper is so full of minute details, and abounds in such extended tables of results, that we shall not attempt to abridge the data upon which its conclusions are founded. The mean velocity of sound, deduced from the experiments is 1142.34 feet in a second.

12. *On the Double Organs of Generation of the Lamprey, the Conger Eel, the Common Eel, the Barnacle and Earthworm, &c. By* Sir E. Home, Bt., V.P.R.S.

It is impossible intelligibly to communicate to our readers the curious contents of this paper, without the aid of the five magnificent plates engraved from Mr. Bauer's drawings, with which it is illustrated.

[The pressure of other matter, obliges us to postpone our account of the contents of the second part of the *Philosophical Transactions* for 1823, (published in November,) until our next Number.]

V. *The Elements of Experimental Chemistry. By* William Henry, M.D., F.R.S., &c. *The ninth edition, comprehending all the recent discoveries, and illustrated with ten plates, by* Lowry, *and several engravings on wood.* 2 *vols.* 8*vo. London*, 1823.

The inertia of the human mind, and the power of prejudice, are no where more conspicuous than in the pertinacity with which compilers of scientific works continue in their successive editions to retain their early classifications of facts, amid the revolutions of the science itself. Having at first taken some pains to plan an edifice, whose proportions and interior distribution they regarded with complacency, they are unwilling to demolish and construct it anew. For the most part, therefore, they content themselves with some petty alterations in its exterior, which may harmonize it a little with modern improvement, and with replacing the decayed and obsolete furniture of some of the apartments, by other more substantial and appropriate.

The respectable author of the *Elements of Experimental Chemistry* had suffered himself, for the preceding two or three editions of his popular work, to fall under the above description. A book, however, intended especially for students, derives a great part of its value from the justness and felicity of its arrangements. Chemical phenomena have been, of late years, so repeatedly exhibited to the world in so many publications, and are, generally speaking, so clear and uncontroverted, that there is little merit in their mere collection. It is the skilful initiation of the Tyro's mind into the methods of chemical research, and the natural collocation and development of details, both as to the facts themselves, and the means by which they were discovered, that are required and expected from the author of an elementary work. In these respects, the model offered by Lavoisier has been too little imitated by late compilers of systems. By studying the elements of that philosopher, the mind not only gets stored with a series of important facts, but acquiring imperceptibly logical force and precision, becomes fitted for conducting independent investigations. How different an impression is made on the student's mind, by some of our late *systematic* performances. A multitude of objects is exhibited to his view, like a phantasmagoreal dance, calculated to bewilder and fatigue the most resolute; and altogether to deter the less zealous from entering this hermetic labyrinth.

The genuine principles of chemical classification were first established by Davy, in his Bakerian Lectures of 1806, 1807, and 1808. Here the electrical relations of the elementary or undecompounded bodies, and of many compounds were demonstrated; relations which served as the basis of his arrangement in the *Elements of Chemical Philosophy*, which he published in 1812. Berzelius indeed has long regarded the electrical relations of chemical bodies, as the ground-work of their classification, but his notions on electro-chemistry are not unfrequently obscure and hypothetical *.

Oxygen, chlorine, iodine, and fluorine, besides their electrical properties, have other characters so prominently defined, as to entitle them to a primary and peculiar place in chemical systems.

* We are sorry to observe that our censure of some of the hypotheses of Berzelius, and more especially of his system of symbols and formulæ, (which we shall, nevertheless, continue duly to administer as occasion may require) has been mischievously misrepresented as a personal attack upon the Professor, for whose talents, industry, and analytical skill we entertain the highest respect, and therefore beg leave to deprecate any such interpretation of our remarks. The most useful, judicious, and skilful, are sometimes mistaken in the estimate of their own powers; "optat Ephippia Bos piger; optat arare caballus." The high character of Berzelius as an acute and successful analyst, and the ability with which he has handled some of the most abstruse theoretical departments of chemistry, gave a mischievous authority to his hypothetical speculations; and our animadversions have been, and will be, solely confined to the latter.

All our respectable British compilers seem now fully possessed with this idea. But M. Theeand, in his third edition (1821,) of his excellent *Traité*, has neglected this principle of arrangement altogether, and has consequently created a strange jumble among the elementary substances. He begins, for instance, with oxygen, and under this head discusses the theory of combustion and of flame, as if these phenomena possessed that indispensable connexion with oxygen, which was the leading article of the Lavoisierian creed. His next great division comprehends the simple combustibles, non-metallic, which are distributed in the following order; hydrogen, boron, carbon, phosphorus, sulphur, selenium, chlorine, iodine, and azote. Thus many of the most beautiful chemical analogies are violated, to the no small perplexity of the student.

Dr. Henry has at length in this edition adopted as the basis of his arrangement, that originally given in Sir H. Davy's *Elements*, and followed up and extended in Mr. Brande's *Manual*. In the sequel of the introduction (which is the introductory lecture long ago delivered in Manchester, and reprinted in the former editions,) he has given a few paragraphs descriptive of the arrangement of the work.

The first chapter entitled "Of a chemical laboratory and apparatus," is chiefly a reprint from the former editions. Some formulæ are now added by Mr. Dalton, for equating the volumes and specific gravities of moist gases. Mr. Dalton assumes 0.620 as the specific gravity of aqueous vapour in air at 60° F, and not 0.472 as Drs. Apjohn and Thomson would have it. (See *Annals of Philosophy*, May, 1822.) "The specific gravity," says Mr. Dalton, "of pure steam compared with that of common air, under like circumstances of temperature and pressure, is according to Gay-Lussac as 0.620 to 1.0."

But as each species of gaseous matter has its volume equally affected by change of temperature, the relation 0.620 to 1, will continue to be equally just at the temperature of 60° F, as at that of 212°, at which point M. Gay-Lussac's experiments were made. Hence we perceive the fallacy of Dr. Thomson's and Dr. Apjohn's determinations in the *Annals of Philosophy* for April and May, 1822. A more popular view of this important practical subject should have been given in an elementary work. To a large proportion of chemical students, Mr. Dalton's exposition will be unintelligible. A table might have been given for reducing the volume of moist air, to that of dry, between the ordinary range of experimenting on gases, *viz.*, from 50° to 70° Fahr.

The second chapter is entitled *Chemical Affinity;* under which head we scarcely expected to find cohesion and crystallization. Here the principles of corpuscular philosophy are inculcated; but we cannot compliment our author, either on the soundness or profundity of his views. His primary enunciation is incorrect. "All

bodies composing the material system of the universe, have a mutual tendency to approach each other, whatsoever may be the distances at which they are placed." Newton established, on the contrary, that when these distances are diminished to a certain point, the attractive forces cease to operate, and the repulsive begin to act. This subject has been amply investigated by Boscovich.

In the following sentence, Dr. Henry's language is contrary to the usage of all good chemical authors. "By the *affinity of aggregation*, the *cohesive affinity*, or more simply *cohesion*, is to be understood that force or power, by which particles or atoms of matter *of the same kind*, attract each other, the only effect of this affinity being an aggregate or mass." The term *affinity* thus employed, tends to introduce confusion into chemical discussions. Geoffroy originally used it to designate those relationships between two or more sets of heterogeneous particles, which caused them to unite into a compound whole; and every chemical writer since, has we believe, used *affinity* as synonymous with the *attraction of composition*, in contradistinction to the attraction of aggregation or cohesive attraction. In fact, the expression cohesive affinity is a solecism, for a thing cannot be said to have an affinity or relationship to itself. We might as well say of a person, that he is related to himself. Precision of language is a primary virtue in an elementary writer.

In the same paragraph, Dr. Henry goes on to say, "But in compound bodies, we may distinguish the force with which the *primary* or *component* atoms are united, from that which the *compound* atoms exert towards each other; the former being united by chemical affinity, and the latter by the cohesive attraction." This is a *meta*physical distinction, which he might as well have let alone, for probability is against it. In considering for example an atom of calcareous spar, we may contemplate its solidity as resulting from the attractive affinity of an atom of carbonic acid for an atom of lime; or of one atom of calcium, one of carbon, and three of oxygen. Let a second atom of calcareous spar be brought into intimate association with the first. The aggregate may be held together either by the reciprocal affinities of the two ultimate atoms of calcium, two of carbon, and six of oxygen, or by those of the two atoms lime and carbonic acid, or by the cohesion of an atom of carbonate of lime to carbonate of lime. We cannot help recognising the co-operation at least, of the former set of forces in the formation of the aggregate; for arrange the ultimate atoms in the solid as we please, still one of carbonic acid will be situated between several of lime, and will exert a greater or less affinity for them all, relative to its position and proximity, and be acted on by several atoms of lime in return.

The first section of the Chapter on Chemical Affinity treats of

cohesion, solution, and crystallization. "The cohesive affinity," says Dr. Henry, "is a property which is common to a great variety of bodies. It is most strongly exerted in solids, and in them it is proportionate to the mechanical force required for effecting their disunion. In liquids, it acts with considerably less energy; and in aëriform bodies, we have no evidence that it exists at all; for their particles, as will afterwards be shewn, are mutually repulsive, and if not held together by pressure, would probably separate to immeasurable distances. Water also in a solid state has considerable cohesion, which is *much* diminished when it becomes liquid, and is entirely destroyed when it is changed into vapour."

We have quoted this passage, not so much for the purpose of exemplifying the practice too common with some systematists of filling up their pages with trite and unmeaning generalities, as to point out its false philosophy. Fully a year before Dr. Henry's work appeared, Dr. Wollaston investigated the constitution of elastic fluidity in a manner worthy of his genius, and had shewn, that "all the phenomena accord entirely with the supposition that the earth's atmosphere is of a finite extent, limited by the weight of ultimate atoms of definite magnitude, *no longer divisible by repulsion of their parts* *." It hence appears that air, not "held together by pressure, would (*not*) probably separate to immeasurable distances."

"Cohesive affinity," says Dr. Henry, "is in solids proportionate to the mechanical force required for effecting their disunion." He should here have distinguished between hardness and tenacity. He should likewise have bestowed at least a wooden cut or two on Haüy's theory of crystallization; for want of which his account of the matter must merely perplex the student. The term *reflecting*, however appropriate to the inventor of the goniometer, is not the correct one for the instrument itself, which was originally named *reflective*.

In section 3, of the chapter on Chemical Affinity, Dr. Henry treats of the proportions in which bodies combine, and of the atomic theory †.

* On the finite extent of the atmosphere. Read at the Royal Society. January, 17, 1822.

† As persons, otherwise clear-headed and well-informed, are continually expressing their inability to comprehend this part of chemistry, we shall endeavour to divest it of rigmarol, and to shew them that it is a branch of chemical theory founded upon a very few and simple facts, which when once in their possession, will enable them not merely to understand its principles, but to appreciate its usefulness and importance. If we subject any true chemical compound to analysis, we shall find that its elements are always in the same proportions, and that from whatever source it be derived, or under whatever circumstances it be formed, they uniformly exhibit the same relative proportion to each other. Water, for instance, is a compound of hydrogen and oxygen, in which the former always bears to the latter, the proportion of 1 to 8. In dry sulphate of magnesia or Epsom salt, the sulphuric acid is to the magnesia uniformly as 40 to 20. Pure white marble, whether it comes from Paros

"3dly. There are many examples in which bodies unite in one proportion only; and in all such cases, the proportion of the ele-

or from Carrara, or from the Pentelic hill, or from Sutherlandshire, or from any other part of the world, is composed of 28 parts of lime united to 22 of carbonic acid: and again 22 parts of carbonic acid, whether extracted from the said marble, or generated by the respiration of animals, or by the combustion of coal or wood, or of the diamond, whether poured forth from the surface of fermenting liquors, or issuing from fissures in the earth, consist in all cases of 6 parts of carbon combined with 16 of oxygen. But it often occurs that bodies combine in more than one proportion, and this happens to be the case with carbon and oxygen, which besides carbonic acid produce carbonic oxide. Now in respect to the latter, if we still suppose the weight of carbon to be 6, that of oxygen is 8, that is just half the quantity existing in carbonic acid; and as on the one hand we find the proportions of the elements of the same compound always in the same relation to each other; so when one substance combines with another in different proportions, to form different compounds, the numbers representing the greater proportions, are exact simple multiples of that denoting the smallest proportion. This doctrine of multiples is of so much consequence that we shall press another instance or two upon the attention of our uninitiated readers. There are two oxides of mercury, the black and the red; in the former 200 parts of the metal are united to 8, and in the latter to 16 of oxygen. There are 5 compounds of nitrogen and oxygen, and if we assume the weight of the nitrogen to be 14, that of the oxygen in the several compounds is respectively 8, 16, 24, 32, and 40; that is, one, two, three, four, and five times 8. So much for the doctrine of multiples. To explain another term used in these disquisitions, let us go back to the marble and Epsom salt. In the former we have discovered 22 parts of carbonic acid united to 28 of lime, forming 50 of carbonate of lime or marble, and in the latter we find 40 of sulphuric acid combined with 20 of magnesia, producing 60 parts of sulphate of magnesia or Epsom salt. If we now suppose these elements differently arranged, forming, for instance, carbonate of magnesia and sulphate of lime, we shall find them obedient to the same proportions, that is, 22 of carbonic acid will unite to 20 of magnesia to form 44 of carbonate of magnesia; and 40 of sulphuric acid will be required by 28 of lime to form 68 of sulphate of lime. Hence is is that the numbers which we have employed to represent the combining weights of the above substances have been termed *equivalent numbers*. If we now draw out a list of commonly occurring elementary or compound bodies, and affix numbers to them representing the smallest proportions in which they combine, in reference to some substance assumed as unity, it is obvious that such a list will present much useful information; for instance,

Hydrogen . .	1	Lime . . .	28
Oxygen . . .	8	Soda	32
Water . . .	9	Phosphoric acid	28
Sulphur . . .	16	Nitric acid . .	54
Sulphuric acid .	40	Potassa . . .	48
Magnesia . .	20		

Now from this table it will be manifest that 9 parts of water consist of 1 hydrogen and 8 oxygen. That 16 parts of sulphur combined with 24 (that is, 3 times 8) of oxygen constitute 40 of sulphuric acid; and that 40 of sulphuric acid will neutralize 20 of magnesia, 28 of lime, 32 of soda, and 48 of potassa, whereas the same weight of these alkaline substances will be neutralized by 54 of nitric acid, and by 28 of phosphoric acid. But whilst proceeding with these lucubrations we had almost forgotten the excellent illustrations of the uses and applitions of such a system of numbers which Dr. Wollaston has annexed to his description of his logometric scale of chemical equivalents, published in the *Philosophical Transactions* for 1814, to which we refer our readers as infinitely luminous, and as rendering any extension of our remarks unnecessary.

ments of a compound, must be uniform for the species. Thus hydrogen and oxygen unite in no other proportions than those constituting water, which by weight are very nearly 11⅓ of the former to 88⅔ of the latter, or 1 to 7⅔." In his preface he says, "Every new edition must reject whatever recent experience has proved to be erroneous." Now there are two very remarkable errors in the above sentence. 1, Hydrogen and oxygen were shewn several years ago by Thenard to unite in other proportions than those constituting water; and 2, The proportions constituting water are known to be not 1 to 7⅓ but 1 to 8. Chlorine and hydrogen would have furnished Dr. Henry with a much better illustration of a definite solitary combination of two elements.

The third section of the chapter on affinity is devoted to the *atomic theory*. Aware of the familiar and daily intercourse which Dr. Henry enjoys with Mr. Dalton, to whom, indeed he dedicates his work, we naturally looked for a more elaborate and consistent exposition of this fundamental subject, than he has given. We regret also to observe that the name of Richter is suppressed, though his labours were directed to the doctrines of chemical equivalents, for some years before Mr. Dalton was known even to have thought on the subject; and though Richter furnished the only rigid method of discovering the atomic weights of neutro-saline bodies. As to Sir H. Davy's ideas on chemical combination, they are evidently (we do not say intentionally) misunderstood by Dr. Henry.. "Sir H. Davy," says he, "has assumed with Mr. Dalton, the atom of hydrogen as unity; but that philosopher, and Berzelius, also have modified the theory, by taking for granted that water is a compound of one proportion (atom) of oxygen, and two proportions (atoms) of hydrogen." We do not know where Dr. Henry has learned this. Sir H. Davy says, "As two *volumes* of hydrogen to one of oxygen enter into the composition of water, the ratio of the hydrogen in water will be to the oxygen as two to fifteen; and it may be regarded as composed of two proportions of hydrogen, and one of oxygen; and the number representing hydrogen will be 1, and that representing oxygen, 15 *. Again, "Mr. Higgins has supposed that water is composed of one particle of oxygen, and one of hydrogen, and Mr. Dalton of an atom of each; but in the doctrine of proportions derived from facts, it is not necessary to consider the combining bodies either as composed of indivisible particles, or even as always united one and one, or one and two, or one and three proportions. Cases will hereafter be pointed out, in which the ratios are very different; and at present, as we have no means whatever of judging either of the relative numbers, figures, or weights of those particles of bodies which are not in contact, our numerical expressions ought to relate only to the results of experiments †." Hence Sir H. Davy's pro-

* *Elements of Chim. Phil.* p. 112. † *Ibid.* p. 114.

portional numbers are those given by experiment, of which the lowest ratio is one *volume* of hydrogen. But what must excite peculiar astonishment in every individual who has studied with any care the principles of reciprocal and multiple combination, is the manner in which Dr. Henry here speaks of Gay-Lussac's theory of volumes, which is, in truth, a legitimate corollary from the atomic theory itself. " In some instances, as in that of water, this law (of gaseous volumes) is not inconsistent with the atomic theory; *but in other instances it cannot be reconciled with the relative weights assigned to the atoms of certain elementary bodies.* In nitrous gas, for example, which Mr. Dalton conceives to be formed by the union of one atom of oxygen with one atom of nitrogen, equal volumes of these gases would give for the relative weights of oxygen and nitrogen, numbers widely differing from those derived by other methods. The *two hypotheses* of atoms, and of volumes, cannot, therefore, both be true; *and from some well ascertained exceptions to the latter, it appears to me that the theory of volumes will scarcely be found tenable**."

We really were astonished at this passage, in the *ninth* edition of a book, of which the author says, " no pains has been spared to render these volumes a *faithful* abstract of the present state of chemistry." It is an indisputable fact that nitrous gas is constituted by the union of one volume of oxygen, and one volume of nitrogen, which, retaining their total bulk after combination, afford a compound gas, of mean specific gravity. It is another fact, equally indisputable, that nitrous oxide is constituted by the union of two volumes of nitrogen, and one of oxygen, which suffer a condensation equal to the volume of oxygen; whence the gas has a corresponding increase of specific gravity. In the first, the comparison of the weights of equal volumes, gives the ratio of oxygen to that of nitrogen as 16 to 14; or 2 atoms to 1 on Dr. Henry's scale. In the second case, the same comparison gives the ratio of 8 to 14, or of 1 atom to 1, on the same scale. Here, therefore, is a perfect accordance between the atomic *hypothesis*, and the *theory* of volumes.

But to examine the *hypothesis* a little more minutely: Let us assume a volume of oxygen so small as to contain only one atom; call its relative weight 16; then it will require for saturation, two such volumes of hydrogen, whose weight will be 2. Next assume a volume of nitrogen equal to the above volume of oxygen. It will contain one atom, and have a relative weight of 14; which will require for saturation three such volumes of hydrogen. But three such volumes are impossible, because they imply the bisection of Mr. Dalton's radical and primary atom, which is absurd.

The *general fact* of volumes requires no such mystifications, as the Daltonian *hypothesis* does. In saying so, we do not mean in

* Henry's *Elem.* I. 52.

the slightest degree, to disparage Mr. Dalton's great merit in establishing, so ably as he has done, the important system of reciprocal and multiple combination. We wish merely to see it stripped of all such trappings as disguise and disfigure it. Among these, the following two positions of Mr. Dalton, expounded by Dr. Henry, may be reckoned. 1. *That an increase of the density of a gas, indicates an increased number of simple atoms, associated in the compound atom.* 2. "Moreover, it is *universally* observed that of chemical compounds, the most *simple* are the most difficult to be decomposed; and this being the case with carbonic oxide, we may naturally suppose it to be more simple than carbonic acid *." Dr. Henry clenches the first position as follows:—"It would be absurd to suppose carbonic acid, which is the heavier body, to be only *once* compounded, and carbonic oxide, which is the lighter, to be *twice* compounded †"

The first position goes to prove that nitrous oxide, a denser gas than nitrous gas, has an increased number of simple atoms, or is more than once compounded. Such is Mr. Dalton's own decision in this very case. The nitrous gas being the lighter, is the simpler body, or is only *once* compounded.

By the second position, however, nitrous gas is *not* the simpler body, but is *more* than once compounded, for it is decomposable by a great many substances which have no effect on nitrous oxide; such as moistened iron or zinc filings, muriate of tin, alkaline sulphites, and aqueous solutions of sulphurets. Thus nitrous oxide is "the most simple, as it is the most difficult to be decomposed." But by the first Daltonian article, it is the *most compounded*, or least simple; which is absurd. We shall leave the framer and expositor of these fancied axioms, to assist each other in getting off the horns of the dilemma at their leisure.

We felt, we must confess, a little alarmed when we first heard Doctor Henry talk so boldly of the "well-ascertained exceptions" to the *hypothesis* of volumes, which were to render "the *theory* of volumes scarcely tenable." But on hunting after his exceptions with some curiosity, we could not find one of them forthcoming in his two volumes. Truly, if the theory of volumes, as developed by Gay-Lussac, shall be found scarcely tenable, we know of nothing in chemical science to which we can venture to attach the anchor of our belief, for nothing is better demonstrated than that theory.

In the above instances our author has merely mistaken the partial enactments of his ingenious friend, for the laws of nature. But we shall see him presently enlist his ideas in foreign service, and advance doctrines incompatible with the principles of his English master, while he fondly imagines himself the true defender of the faith.

In section 5th, speaking of Berthollet's doctrines of affinity, he very properly quotes Professor Pfaff's experiments, to prove that

* Henry's *Elem.* I. 50. † *Ibidem, loco citato.*

"in various cases, when two acids are brought into contact with one base, the base unites with one acid, to the entire exclusion of the other." Dr. Henry might have also adduced the mutual precipitation of metals from their saline combinations, in which the displacement is complete, and not partial, as Berthollet's doctrines lead us to infer, when the force of cohesion is equally active. Yet Dr. Henry, in his eighth section, entitled *Experimental Illustrations of Chemical Affinity*, seems to lose sight of what he had previously propounded; for he prints the following axiom in italics as one to be illustrated by experiment. "XIV. In every instance, in comparing the affinities of two bodies for a third, a weaker affinity in one of the two compared will be found to be compensated by increasing its quantity." We should like to know what quantity of silver or of oxalic acid may be requisite to decompose an ounce of sulphate of lead.

Dr. Henry's third chapter is dedicated to Caloric. The facts, which are distributed into four sections, appear to be well selected, and fairly stated. In describing M. Breguet's thermometer, in the second section, he appears to misunderstand its construction. "It consists," says he, "of a slip of silver, and another of platinum, coiled into a spiral, one end of which is fixed, while the other is connected with an index, which traverses a graduated circular plate." There is only one slip, in which the platina and silver are united face to face with gold solder. The difference of expansion between the two metals by variation of temperature, causes the spiral to increase or diminish the degree of its curvature, and thus makes the needle traverse the graduated circle, attached at right angles to the axis of the spiral.

The 4th Chapter treats of light, the phenomena of the prismatic spectrum, solar phosphori, &c.; and in the 5th we have brought before us the important subject of "the chemical agencies of common and galvanic electricity," a title which would have pleased us better, had the words "common and galvanic" been omitted; but this is a trifle, and the chapter itself a very good one; it treats in successive sections of the construction of galvanic apparatus, of the identity of galvanism and common electricity; of the chemical agencies of electricity; of the theory by which they are best explained; of the hypothesis of the origin of electricity in galvanic arrangements, and of the phenomena of electro-magnetic motion: upon a few of the topics discussed in this chapter, we must beg leave to offer a few observations.

And in the first place, we should advise our author in his next edition, entirely to re-model the first section, in which we are brought at once to the discussion of simple galvanic circles, and compound galvanic circles, without a word of prefatory matter respecting the laws of electrical excitation, and the new properties which bodies acquire whilst under its influence; we should also

recommend him to erase the second section, and to enlarge and extend the third, illustrating it by a few wood-cuts of the apparatus there referred to. The fourth section entitled "*Theory* of the changes produced by (galvanic) electricity;" and the fifth, on the theory of the action of the galvanic pile, touch upon some very intricate and abstruse parts of chemical reasoning, but upon which no very satisfactory or luminous conclusions have as yet been arrived at. We are generally led to regard bodies as endowed with certain inherent or natural electrical states, which render them either attractive of each other, or of surfaces oppositely electrified; we consider these opposite electricities as partially or entirely annihilated by combination, and to this source we *may* refer that remarkable extrication of heat and light, which so commonly announces intense chemical action. We *may* account for the destruction of common chemical attraction between two bodies, by supposing one of them to have an electrical state opposite to its natural one conferred upon it; while by exalting the natural electrical energies, we *may* explain their increased tendency to union. But all these assumptions are purely hypothetical, and still more so are those which our author has adduced in reference to the action of the pile, that is, to the source of its electricity. When we know what electricity is, we may presume to talk upon these matters, but at present we must rest content with a knowledge of facts and effects, and our stock must be infinitely and diligently multiplied before we can presume to determine upon the source of electricity, either in the common machine, or in the pile of Volta.

The sixth section gives a succinct and tolerably correct account of the most important electro-magnetic phenomena, in which, however, hypothesis and facts are rather too indiscriminately blended; and although we have great respect for Messrs. Arago and Ampere, we think they have indulged in electro-magnetic speculations, which border upon absurdity. Our information upon this very curious subject is extremely limited, and we do not hesitate to ascribe to the researches of Oersted, Davy, Wollaston, Faraday, and Siebeck, all that has really and actually been acquired in respect to it. The grand and important fact that a metallic wire, through which a current of electricity is passing, affects a magnetic needle, we owe to M. Oersted. Let us imagine a wire of platinum placed in the magnetic meridian, and a delicately-suspended magnetic needle underneath, near and parallel to it; in this state of things nothing particular will happen either to the wire or the needle: let us now connect the extremities of the wire with a voltaic battery, the right-hand extremity being in contact with the last zinc plate and the left-hand end with the last copper-plate, so that in the hypothetical language of electricians, a current of electricity may traverse the wire from the right to the left. Under these circumstances the magnetic needle will no longer remain pointing N. and

S., or in the magnetic meridian, but will be suddenly diverted from its natural position and place itself at right angles to the wire, its northern extremity becoming somewhat elevated, and its southern depressed. If we now reverse the direction of the electric current, we shall at the same time reverse the position of the needle; its south end will veer round to the spot formerly occupied by the N., and *vice versâ* in regard to its north end. From this statement we may in some measure anticipate what would happen, when the wire is placed vertically instead of horizontally, in respect to the needle,—but we shall not enter into the details of position, least we perplex the main argument. For all this and much more important information connected with it, we are indebted to Professor Oersted. It might have been expected that a wire, under the influence of common electricity, would affect the needle in the same way as the galvanic conductor; Sir H. Davy instituted experiments which proved this to be the case, and he showed that to communicate strong and permanent polarity to a steel bar, it became necessary to attach it *transversely* to the electrified wire, or to place it in that position at a small distance from it. His researches led him moreover to a number of curious facts connected with the communication of magnetism by electricity, and his paper is full of curious suggestions connected with this inquiry*.

We now come to Dr. Wollaston, who, upon hearing of Oersted's discovery, immediately proceeded to convince himself of its correctness, and to examine into the theory of the phenomena; the result of his inquiries led him to infer, if we mistake not, that a current or vortex of magnetism was put into motion round the axis of the conducting wire, consequently, that no fixed magnetic poles could be observed; but that the pole of a magnet, on approaching the conducting wire, would cause it to attempt to revolve upon its own axis, in a direction dependent upon that of the electric current. Hence, the idea of magnetic rotation, which has since given rise to such an amusing multiplicity of apparatus, certainly first occurred to Dr. Wollaston; but having established his very ingenious and satisfactory theory, and having convinced himself and most of his friends, of its adequacy to the explanation of the phenomena, he seems to have dropped the inquiry, which in respect to rotation was pursued upon other grounds by Mr. Faraday, who constructed the first apparatus in which the pole of a magnet was made to revolve about the axis of a wire-transmitting electricity. In relation to this subject, we refer our readers to his papers in this Journal†, and to his "Historical statement respecting Electro-magnetic Rotation.‡"

In the course of last year Dr. Siebeck of Berlin, showed than the electricity excited by heating compound metallic bars, might be rendered evident by its effect upon a magnetic needle, and Messrs.

* *Phil. Trans.* 1821. † Vol. xii, p. 74 and 416. ‡ Vol. xv, p. 288.

Fourier and Oersted have extended these researches, and developed a series of very interesting phenomena, connected with the generation of electricity in metallic bars by change of temperature. These circuits they call *thermo-electric*, in opposition to the common galvanic arrangements which they properly enough term *hydro-electric*. Some details of the experiments will be found in a former Number, under the head of *Foreign Science**.

Chapter 6th. On the electro-negative bodies, oxygen, chlorine, iodine, and fluorine, is clearly and candidly drawn up. The next, great division contains the electro-positive bodies, subdivided into groups, each of which occupies a chapter.

Chapter 7th is entitled, "Of simple acidifiable bodies, (not metallic,) and their combinations with oxygen, chlorine, iodine, and fluorine." Here we have the usual six bodies, hydrogen, nitrogen, charcoal, boron, phosphorus, and sulphur, to which he has added selenium. We cannotapprove of the single term *acidifiable* applied to characterize the above bodies. Nitrogen and hydrogen may as properly be styled alcalifiable bases, as acidifiable; for they form ammonia. And when hydrogen combines with chlorine, we may regard the chlorine as the acidifiable base, as well as the hydrogen. Dr. Henry should have contented himself with the title electro-positive bodies (non-metallic,) which involves no hypothesis, and to which no objections can be urged. The metals, on account of their number, may indeed, be conveniently subdivided into such as afford alkalis, earths, oxides, and acids. The details of this chapter merit equal praise to that which we have bestowed on the preceding. Under the compound of hydrogen and nitrogen (ammonia) he has introduced the salts formed with this alkali, and the acids he had previously described. The reasons which he assigns for this insulation of the ammoniacal salts among the non-metallic electro-positives, and their compounds, do not appear to us satisfactory.

Chapter 9th contains the metals with their oxides, chlorides, iodides, and the combinations of the oxides with the previously described acids, or the salts. His details appear to be correct, and as minute as the size of his work would admit.

It is in the general discussions or philosophy of chemistry that Dr. Henry seems to be least at home. Thus in the introductory section on the general properties of metals, we find him retailing as important special laws, propositions which have been long ago merged into the great system of chemical equivalents, of which they constitute particular corollaries. Indeed one of the general principles advanced by Dr. Henry, is manifestly no general principle at all, as we shall presently see.

That the quantity of acid which different metals require for saturation is in direct proportion to the quantity of oxygen in their

* Vol. xv. p. 126.

oxides was an important fact, when M. Gay-Lussac first announced it in the second volume of the *Mémoires D'Arcueil.* But a single glance at Dr. Wollaston's scale shews that fact to be merely one particular aspect of the doctrine of equivalents; and Dr. Henry should have therefore traced it to its source. The greater the proportion of oxygen in a protoxide, the nearer does its atomic weight, or equivalent, stand to the beginning of the scale, and of course, the greater its saturating ratio. Thus, as 100 of lead take 7.7 of oxygen to form litharge, while 100 of mercury take 4 to form the black oxide, the former will take a quantity of acid compared to the latter, as 7.7 to 4; for 7.7 : 4 :: 25 : 13; that is, the proportions of oxygen in protoxides are invariably as the atomic weights of the metals; and the less the atomic weights, the less of them is requisite to saturate a given portion of any acid.

"It has been deduced," says Dr. Henry, "by Berzelius, as a general principle, from the comparison of a great number of facts, that in all neutral salts, the oxygen of the acid is a multiplication of that of the base, by some entire number." The law he apprehends, may be expressed more generally in the following terms: *When two oxidated substances enter into a neutral combination, the oxygen of that which, in a galvanic circle, would be attracted to the positive pole, is a multiplication by an entire number of the oxygen of that which would be deposited at the negative pole.* The chemical associate of Mr. Dalton should have known that this is neither a general principle, nor a just proposition. The particular facts in unison with it, which originally misled Berzelius, are those exhibited in the union of acids, containing two or three atoms of oxygen, with bases containing only one. So far the thing is plain. Thus sulphuric acid contains three proportions of oxygen, and will hence afford a threefold multiple, (not multiplication,) of oxygen, in its combinations with all the protoxides. But in some of its combinations with the deutoxides, this fancied law is no longer applicable, but would lead to serious errors. For in them, the ratio of oxygen in the acid, is not unfrequently to that in the base, as 3 to 2 or 1½ to 1. Again, those acids which contain two atoms of oxygen, will not, in their compounds with bases also containing two atoms, give a multiple, but an equal proportion of oxygen. Anhydrous carbonate of copper is in this predicament. If again we consider those acids which contain only one atom of oxygen, as the phosphorous, the oxygen will be either a *sub*-multiple of that in the bases, or equal to it in quantity, according as it is combined with a deutoxide or a protoxide. This is also the case with the hyposulphites. Finally, with regard to some of the nitrates, and chlorates of deutoxides, the relation of oxygen in the acids, will be to that in the bases as 5 to 2. In the subnitrate of copper, this relation is as 5 to 4, a proportion which places in a striking point of view the absurdity of Berzelius's law. If we excuse him on account of the early period when

it was promulgated, before the theory of equivalents was properly developed, what defence can Dr. Henry offer, for incorporating it in his systematic compilation of 1823?

Another supposed law of Berzelius' which Dr. Henry calls important, is enunciated as follows: "*The quantities of different bases required to saturate a given quantity of any acid, all contain the same quantity of oxygen.*" * This is our old friend with a new face. Let any one take up Dr. Wollaston's scale, and slide any number opposite to a given acid, it is obvious that the number opposite oxygen is the equivalent to all the protoxide bases in the list. By taking such partial views, we may fabricate as many canons as we please.

In his general discussion on metallic alloys, Dr. Henry says, "To estimate exactly, however, either the increase or diminution of density, requires an attention to several circumstances." He then refers in a foot note to Aikin's dictionary, article *Alloy*. Is not Dr. Henry aware that the rule given in that respectable work, for computing the mean density of an alloy, is a false one, and leads to very erroneous results?

We cannot approve of his systematic arrangement of the metals, which he has indeed copied from Thenard, along with several tables. His two *general* classes of the metals have been long received; the oxides of the first class are not reducible by heat alone, those of the second are. The first class has three subdivisions. 1. "*Metals that are either known from experiment, or believed from analogy, to absorb oxygen, at high degrees of heat, and to decompose water at common temperatures.*" Here are placed the 6 metals, potassium, sodium, lithium, calcium, barium, and strontium. Those presumed by analogy to belong to this subdivision, are the metallic bases of the earths proper. 2. "*The second subdivision includes those metals which absorb oxygen from atmospheric air at high temperatures, and decompose water, but* NOT UNDER *a red heat.* These are 5 in number, *viz.*, manganese, zinc, iron, tin, and cadmium. 3. "Metals of the third subdivision are capable, like the foregoing, of absorbing oxygen at high temperatures, but not of decomposing water at any temperature." Here we have 14 metals, out of Thenard's 15, Dr. Henry having transferred nickel to the 2nd class of noble metals.

We beg leave to remark, that the metals of the first subdivision absorb oxygen, not merely at high degrees of heat, but at ordinary temperatures. Potassium and sodium, tarnish and oxidize speedily in dry air. Their characteristic property is to decompose cold water with explosive violence. The metals of the second subdivision are not truly represented by Dr. Henry, when he says, "they absorb oxygen from the air, at high temperatures, and decompose water, but not under a red heat." We shall give him three authorities for our opinion, which he will not venture to gainsay. "* Manganese, when exposed to the air, attracts oxygen

* *Thomson's System of Chem. 6th Edit. I.* 416.

with considerable rapidity. When thrown into water, it decomposes that liquid, with considerable rapidity."

"By exposure to the air for some time, zinc acquires a greyish colour on the surface, which is owing to a partial oxidizement. Zinc filings very slowly decompose water, hydrogen gas is evolved, and oxygen combines with the metal *."

"A temperature of, from 120° to 140° Fahr., renders water decomposable by iron, especially when the metal bears a considerable proportion to the water†."

We apprehend that the arrangement of the metals, best adapted for students, would be to begin with the alkalifiable, next to proceed to the geofiable, whereby a knowledge of the alkaline and earthy re-agents, so useful in metallic research, would be acquired at the outset. So far our plan agrees with Dr. Henry's. The ordinary metals might then be examined as nearly as possible in the order of their affinities for oxygen, terminating the list with platinum, and its companion metals. The old distinctions of metals, and semi-metals, perfect and imperfect, base and noble, should be for ever banished from chemical discourse. They are all the perfect and noble productions of nature, and the multiplication of their species is one of the chief achievements of modern science.

We have looked over our author's 10th and 11th chapters on vegetable substances, and their decomposition, as well as the 12th, on animal substances, and the 13th on animal products. We think that the facts are judiciously abridged, and fairly stated. The 14th chapter on chemical analysis is divided into 3 sections; of which the first treats of gaseous analysis, the second of that of mineral waters, and the third of that of minerals. In these details, he has followed Thenard and other writers on analysis with fidelity. We could have wished him to have been a little less sparing of references to the works from which he has borrowed. "Nothing," says poor Richard, "gives an author so great pleasure as to find his works respectfully quoted by others."

In the preceding article we have diligently exposed what to us appear the prominent errors and principal failures in Dr. Henry's book, in the hope that our remarks may influence the merits of his tenth edition, and in the belief that he will not be offended with the freedom of our strictures. In conclusion, we must add that there is very much more to praise than to censure, in this work; in matters of detail it will furnish a valuable guide to the chemical student, and will uphold the reputation of its author, as a candid and careful compiler, who speaks of his own inquiries without egotism, and who discusses controverted, abstruse, and uncertain points, with that becoming diffidence and candour which shows him (with the Daltonian exceptions above-named) "nullius addictus in verba magistri."

* *Sir H. Davy's Elements*, 371. † *Henry's Elements*, 9*th Edit. II.* 17.

Art. XVII. ASTRONOMICAL AND NAUTICAL COLLECTIONS.

No. XVI.

i. *Description of a New* Tide Gauge.

It is proposed to fix a pipe, with an open mouth, and a triangular orifice (△) at its side, in contact with any convenient part of a bridge or pier that is situated below low-water mark, and to bring from it a pipe, resembling those which are used for the distribution of gas, into any room of a neighbouring house, that may be chosen for the purpose of observation, and there to let it terminate in a well closed reservoir, provided with a little forcing syringe, and with an open barometer gauge, to which a manometrical gauge may be added, if required.

Immediately before each observation, it will be proper to work the syringe, until the gauge becomes stationary, by the escape of the air under the water, so that the column of compressed air may always begin from the level of the upper angle of the triangular orifice; the height of the gauge will then obviously indicate the height of the surface of the water above this level. It would only be necessary, if the height of the reservoir above the orifice were considerable, to apply a small correction for the excess of the weight of the air in the pipe, above a similar column of the external air; this correction being always additive. The gauge might have a double graduation, one for its own height, the other for that of an equivalent column of water.

Brighton, 22d *Oct.* 1823.

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ii. *Catalogue of the* Orbits *of all the* Comets *hitherto computed.* By Dr. Olbers and Professor Schumacher. Astr. Abh. I.

(Concluded from page 151.)

N.	Delambre	Date.	Passage of the Perihelium in Parisian mean time.	Longitude of the Perihelium.	Longitude of the ascending node.	Angle between the Perihelium and the node.	Inclination.	Distance in the Perihelium.	Log. Dist. Perihelium.	Log. mean motion.	Eccentricity.	Direction.	Name of the Computer.
			h ′ ″	s ° ′ ″	s ° ′ ″	s ° ′ ″	° ′ ″						
71	70	1770	Aug.13 13 5 0	11 26 16 26	4 12 0 0	7 14 16 26	1 33 40	0.674381	9.828906	0.216769	0.7857654	D	Lexell
			14 0 13 24	11 26 26 13	4 12 17 3	7 14 9 10	1 34 30	0.676893	9.830520	0.214348		D	Pingré
			9 0 32 46	11 26 12 50	4 16 14 0	7 9 58 50	1 45 20	0.628720	9.798457	0.262443		D	Slop
			9 3 38 0	11 25 57 0	4 12 0 0	7 13 57 0	1 55 0	0.631000	9.800029	0.260085		D	Lambert
			8 19 26 0	11 26 19 28	4 14 21 45	7 11 57 43	1 49 5	0.627575	9.797666	0.263629		D	Rittenhouse
			13 12 37 35	11 26 15 11	4 11 54 54	7 14 20 17	1 34 31	0.674360	9.828889	0.216794	0.7854736	D	Burckhardt
			13 12 39 43	11 26 16 38	4 11 52 46	7 14 23 52	1 33 50	0.674300	9.828853	0.216849	0.78554	D	idem
72	71	1770	Nov.22 5 48 0	6 28 22 44	3 18 42 10	8 20 19 26	31 25 55	0.528240	9.722833	0.375879		R	Pingré
73	72	1771	Apr.18 22 14 27	3 13 28 13	0 27 51 0	2 15 37 13	11 15 29	0.905760	9.957013	0.024609		D	idem
			19 0 39 31	3 13 48 21	0 27 49 37	2 15 58 44	11 16 44	0.901878	9.955148	0.028606		D	Prosperin
			19 5 10 42	3 14 2 54	0 27 50 27	2 16 12 27	11 16 0	0.903370	9.955864	0.026332	1.00944	D	Burckhardt
			19 4 25 36	3 13 57 52	0 27 56 16	2 16 1 36	11 15 28	0.9020537	9.9552324	0.0272797		D	Encke
			19 5 15 40	3 14 8 16	0 27 51 55	2 16 11 21	11 15 19	0.9031632	9.9559204	0.0262477	1.0093698	D	idem
74	73	1772	Feb.18 20 50 35	3 18 6 22	8 12 43 5	7 5 23 17	18 59 40	1.018140	0.007807	9.948418		D	Lalande
			23 10 48 0	3 25 6 25	8 11 11 56	7 13 54 29	18 2[illegible] 24	1.045640	0.019382	9.932055		D	Burckhardt
			20 3 3 0	3 20 6 0	8 12 25 54	7 7 40 6	18 51 6	1.028120	0.012042	9.942066	0.903148	D	Bessel
			19 2 19 25	3 20 14 54	8 11 0 1	7 6 14 53	18 17 38	1.013590	0.005865	9.951330		D	idem
			9 5 0 0	3 0 17 0	8 21 9 0	6 9 8 0	20 28 0	0.891800	9.950270	0.034730	0.67692	D	Gauss
			8 1 0 0	3 7 21 0	8 23 24 0	6 13 57 0	17 39 0	0.911800	9.959900	0.020280		D	idem
75	74	1773	Sep. 5 11 18 45	2 15 35 45	4 1 15 37	10 14 20 8	61 25 21	1.018140	0.054576	9.878264		D	Pingré
			5 17 9 2	2 16 10 26	4 1 20 0	10 14 50 26	61 30 0	1.1339	0.056965	9.874681		D	idem
			5 5 5 43	2 15 9 17	4 1 10 26	10 13 58 51	61 19 7	1.2155	0.051100	9.883478	0.9930752	D	Lexell
			5 5 55 0	2 15 15 50	4 1 12 11	10 14 3 39	61 20 57	1.124865	0.053115	9.880456	0.9951225	D	idem
			5 11 29 54	2 15 28 17	4 1 13 4	10 14 15 13	61 18 22	1.130095	0.054318	9.878651	1.0037085	D	idem
			5 14 11 11	2 15 17 0	4 1 8 20	10 14 8 40	61 15 11	1.133231	0.052961	9.880687	1.0024901	D	idem
			5 9 12 1	2 14 57 41	4 1 4 49	10 13 52 52	61 13 19	1.129694	0.051272	9.883220	0.9934997	D	Pingré
			5 14 43 9	2 15 10 58	4 1 5 30	10 14 5 28	61 14 17	1.12689	0.051881	9.883308		D	Burckhardt
76	75	1774	Aug.14 4 20 0	10 16 27 57	6 0 57 26	4 15 30 31	82 47 40	1.42528	0.153900	9.729278		D	Saron
			14 17 56 0	10 16 48 24	6 0 50 13	4 15 58 11	82 48 38	1.42528	0.153900	9.729278		D	idem
			15 5 17 0	10 17 26 0	6 1 22 0	4 16 4 0	82 21 0	1.426005	0.154121	9.728947		D	Boscovich
			15 10 55 35	10 17 22 4	6 0 49 48	4 16 32 16	83 0 25	1.429	0.154906	9.727769		D	Méchain
			14 12 0 0	10 16 38 0	6 0 54 0	4 15 14 0	82 45 0	1.425	0.153815	9.729406		D	Du Séjour

N.	Delambre	Date.	Passage of the Perihelium in Parisian mean time.	Longitude of the Perihelium.	Longitude of the ascending node.	Angle between the Perihelium and the node.	Inclination.	Distance in the Perihelium.	Log. Dist. Perihelium.	Log. mean motion.	Eccentricity.	Direction.	Name of the Computer.
			h ′ ″	s ° ′ ″	s ° ′ ″	s ° ′ ″	° ′ ″						
76	75	1774	Aug. 17 13 0 0	11 13 19 0	6 3 32 0	5 9 47 0	83 30 0	1.457	0.163400	9.714938		D	Bode
			15 20 4 42	10 17 27 40	6 0 44 34	4 16 43 6	83 20 6	1.132869	0.1562066	9.7258184	1.0282955	D	Burckhardt
77	76	1779	Jan. 4 2 20 30	2 27 14 0	0 25 3 1	2 2 10 59	32 26 14	0.713218	9.853222	0.178295		D	Saron
			4 2 12 0	2 27 18 11	0 25 5 57	2 2 7 14	32 24 0	0.713127	9.853167	0.180378		D	Méchain
			4 2 24 30	2 27 13 40	0 25 3 57	2 2 9 43	32 25 30	0.713187	9.853003	0.180324		D	D' Angos
			4 2 54 20	2 27 12 55	0 25 4 19	2 2 8 36	32 24 44	0.712946	9.853057	0.180548		D	Reggio
			4 2 29 0	2 27 16 0	0 25 5 0	2 2 11 0	32 24 0	0.7137	9.853516	0.179854		D	Oriani
			3 18 18 30	2 26 52 29	0 25 2 55	2 1 49 34	32 41 32	0.710901	9.852811	0.180912		D	idem
			4 2 29 1	2 27 14 19	0 25 7 9	2 2 7 10	32 18 24	0.713218	9.853220	0.178292		D	Prosperin
			. . . . .	2 27 18 22	0 25 9 20	2 2 9 2	32 15 6	0.713688	9.853508	0.179866		D	idem
			4 4 21 23	2 27 18 44	0 25 8 23	2 2 10 21	32 16 56	0.713623	9.853469	0.179925		D	idem
			4 2 13 41	2 27 14 27	0 25 4 10	2 2 10 17	32 30 57	0.713158	9.853186	0.180349		D	Zach
			4 2 40 0	2 27 9 40	0 24 57 18	2 2 12 22	32 31 7	0.713115	9.853160	0.180388		D	Pacassi
78	77	1780	Sep. 30 20 16 22	8 6 30 14	4 4 0	7 27 29 46	53 56 28	0.097807	8.990371	1.474571		R	Lexell
			30 16 8 24	8 6 19 21	4 4 30	7 28 10 39	53 15 20	0.100468	9.002026	1.457089		R	idem
			30 7 29 51	8 5 54 55	4 5 30	7 29 35 5	51 56 33	0.106127	9.925826	1.421380		R	idem
			30 18 12 50	8 6 21 18	4 4 9 19	7 27 48 1	53 48 15	0.099256	8.996755	1.464996		R	Méchain
79	78	1780	Nov. 23 19 0 0	2 5 7 0	5 1 48	9 3 19 0	84 15 0	0.336	9.526	0.671		D	Boscovich
			28 20 26 0	8 6 52 0	4 21 1	8 14 9 0	72 3 30	0.51528	9.712041	0.332067		R	Olbers
80		1781	Jul. 7 4 41 20	7 29 11 25	2 23 0 38	5 6 10 47	81 43 26	0.775861	9.889881	0.125452		D	Méchain
81	80	1781	Nov. 29 12 42 46	0 16 3 28	2 17 22 52	2 1 19 24	27 13 8	0.961013	9.982729	9.986031		R	idem
			29 12 42 46	0 16 3 7	2 17 22 55	2 1 19 48	27 12 4	0.960995	9.982721	9.986046		R	idem
			29 12 42 46	0 16 3 7	2 17 22 55	2 1 19 48	27 12 4	0.960995	9.982723	9.986046		R	Legendre
82	81	1783	Nov. 15 5 53 23	1 15 24 46	1 24 13 50	11 21 10 56	53 9 9	1.56530	0.194598	9.66823		D	Méchain
			15 5 53 30	1 15 25 0	1 24 14 0	11 21 11 0	53 9 0	1.565330	0.194606	9.668220		D	idem
			13 6 13 0	1 13 58 47	1 24 10 10	11 19 48 37	54 9 53	1.56738	0.195175	9.667366		D	Méchain
			20 9 26	1 19 4 30	1 21 10 45	11 24 53 45	52 19 57	1.57718	0.197881	9.663307		D	and
			Oct. 23	0 27 41 56	1 24 26 51	11 3 18 5	56 46 28	1.47189	0.167876	9.708314		D	Saron
			Nov. 19 12 0 11	1 20 3 8	1 25 45 20	11 24 17 48	44 53 24	1.45440	0.1626820	9.7161039	0.5395345	D	Burckhardt
			19 13 38 54	1 19 31 55	1 25 12 0	11 24 19 55	17 43 0	1.49532	0.1747341	0.6980371	0.6784	D	idem
83	82	1784	Jan. 21 4 56 47	2 20 41 24	1 26 49 21	11 6 4 57	51 9 12	0.707858	9.849916	0.185209		R	Méchain
			21 4 48 0	2 20 39 22	1 26 44 2	11 6 4 40	51 15 1	0.708160	9.850181	0.184931		R	idem

N.	Delambre	Date.	Passage of the Perihelium in Parisian mean time.	h ′ ″	Longitude of the Perihelium. s ° ′ ″	Longitude of the ascending node. s ° ′ ″	Angle between the Perihelium and the node. s ° ′ ″	Inclination. ° ′ ″	Distance in the Perihelium.	Log. Dist. Perihelium.	Log. mean motion.	Eccentricity.	Direction	Name of the Computer.
84	84	1785	Jan. 27	7 58 4	3 19 51 56	8 24 12 15	6 25 39 41	70 14 12	1.143398	0.058108	9.872832		D	Méchain
85	85	1785	Apr. 8	11 29 0	9 27 34 40	2 4 44 10	4 7 10 0	87 7 0	0.427587	9.631024	0.513592		R	Saron
86		1786	Jan. 30	20 34 0	5 6 38 0	11 4 8 0	6 2 30 0	13 36 0	0.32386	9.51056	0.69429	0.84836	D	Encke
87	86	1786	July 7	22 0 12	5 9 25 36	6 14 22 40	10 25 2 56	50 54 28	0.41010	9.612889	0.549705		D	Méchain
			8	13 44 22	5 8 38 30	6 15 23 32	10 23 14 58	50 58 33	0.39424	9.595763	0.566484		D	Reggio
88	87	1787	May 10	19 58 0	0 7 44 9	3 16 51 35	3 9 7 26	48 15 51	0.34891	9.542714	0.610057		R	Saron
89	88	1788	Nov. 10	7 35 0	3 9 8 27	5 7 10 38	1 28 2 11	12 28 20	1.063012	0.026538	9.920521		R	Méchain
			10	7 34 47	3 9 8 7	5 6 56 43	1 27 48 36	12 27 40	1.063012	0.026538	9.920391		R	idem
90	89	1788	Nov. 20	9 13 45	0 23 12 22	11 21 42 15	1 1 30 7	64 52 32	0.766911	9.885998	0.131146		D	idem
			20	7 25 0	0 22 49 54	11 22 24 26	1 0 25 28	64 30 24	0.757313	9.879276	0.141215		D	idem
91	90	1790	Jan. 15	5 15 0	2 0 14 32	5 26 11 46	3 25 57 14	31 54 15	0.753097	9.879725	0.140541		R	Saron
			16	13 7 30	1 28 24 45	5 22 50 2	3 24 25 17	29 41 7	0.717336	9.873516	0.149854		R	idem
92	91	1790	Jan. 28	7 15 30	3 21 44 37	8 27 8 37	6 24 36 0	56 58 13	1.063286	0.026650	9.920153		D	Méchain
93	92	1790	May 21	5 56 15	9 3 42 27	1 3 11 2	3 29 27 35	63 52 27	0.757960	9.901981	0.107156		R	idem
			20	11 30 0	9 4 57 20	1 5 14 0	4 0 16 40	63 35 0	0.791005	9.898179	0.112859		R	Englefield
94	93	1792	Jan. 13	13 44 13	1 6 29 42	6 10 46 15	5 4 16 33	39 46 55	1.293023	0.111605	9.792719		R	Méchain
			13	12 59 56	1 6 20 32	6 10 42 9	5 4 21 37	39 45 47	1.047105	0.111156	9.792844		R	Zach
			13	3 44 5	1 6 30 20	6 10 46 53	5 4 16 33	39 46 55	1.293023	0.112161	9.791883		R	Méchain
			15	6 9 0	1 4 43 0	6 11 55 0	5 7 12 0	41 5 0	1.2918	0.111795	9.793335		R	Englefield
95	94	1792	Dec. 27	4 55 0	4 16 5 33	9 13 17 36	4 27 12 3	49 0 24	0.965812	9.984893	9.982789		R	Méchain
			27	7 56 27	4 15 52 35	9 13 14 44	4 27 22 9	49 7 13	0.966829	9.985350	9.982103		R	Piazzi
			27	6 14 41	4 15 59 21	9 13 15 17	4 27 15 53	49 1 45	0.966287	9.985106	9.982469		R	Prosperin
			27	6 45	4 15 57 0	9 13 16 0	4 27 19 0	42 2	0.9663	9.985112	9.982469		R	Saron
96	95	1793	Nov. 4	20 21 0	7 18 42 0	3 18 29 0	7 29 47 0	60 21 0	0.4034	9.605736	0.551524		R	idem
97	96	1793	Nov. 18	15 38 0	2 11 0 0	0 2 20	2 10 40	51 56 0	1.5045	0.177392	9.691010		D	idem
			18	17 30 0	2 21 4 51	0 2 23 55	2 18 40 56	51 56 46	1.50446	0.177388	9.691046		D	idem
			28	14 33 5	2 25 58 58	11 29 4 18	2 26 54 10	47 35 5	1.400026	0.146130	9.7109213	0.7347635	D	Burckhardt
(86)	97	1795	Dec. 15	8 29 50	5 10 29 0	11 23 14	5 17 15	22 10	0.24379	9.387016	0.873604		D	Olbers
			15	15 30 0	5 7 37 0	11 13 23 0	5 24 14 0	10 3 0	0.258	9.411629	0.842699		D	Bouvard
			15	0 15 33	5 13 36 40	11 29 11 45	5 14 24 55	24 16 45	0.22662	9.355298	0.927181		D	Zach
			15	9 52 26	5 10 21 47	11 21 15 56	5 19 5 51	21 45 11	0.21521	9.380538	0.875822		D	Olbers
			15	9 2 2	5 9 53 20	11 21 58 47	5 17 54 39	21 53 2	0.24101	9.387465	0.874017		D	idem

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			h ′ ″	s ° ′ ″	s ° ′ ″	s ° ′ ″	° ′ ″						
(86)	97	1795	Dec.15 9 27 53	5 10 20 49	11 21 47 17	5 18 33 32	21 45 52	0.211539	9.3883480	0.8776063		D	Encke
			21 10 44 22	5 6 41 20	11 4 39 22	6 2 1 58	13 42 30	0.331550	9.5244615	0.6734360	0.8488828	D	idem
98	98	1796	Apr. 2 19 55 6	6 12 44 13	0 17 2 16	6 4 18 3	64 54 33	1.57816	0.198151	9.662902		R	Obers
99	99	1797	July 9 2 40 31	1 19 27 8	10 29 15 37	9 9 48 29	50 40 31	0.52661	9.721489	0.3778946		R	idem
			10 9 16 0	1 26 7 0	11 1 40 0	9 5 33 0	43 12 0	0.463	9.66558	0.46176		R	Bode
			9 2 53 52	1 19 34 42	10 29 16 30	9 9 41 48	50 35 50	0.52545	9.720531	0.379332		R	Bouvard
100	100	1798	Apr. 4 11 15 51	3 14 59 0	4 2 9 0	11 12 50 0	43 52 10	0.481758	9.685527	0.431838		D	Olbers
			4 12 7 37	3 15 6 57	4 2 12 21	11 12 54 36	43 44 42	0.484586	9.685372	0.432070		D	Burckhardt
101	101	1798	Dec.31 22 5 15	1 3 35 5	8 9 30 2	7 5 54 57	42 14 51	0.77479	9.889186	0.126349		R	Olbers
			31 13 8 15	1 4 29 48	8 9 30 4	7 5 0 16	42 23 25	0.77968	9.891917	0.122253		R	Burckhardt
			31 13 26 24	1 4 27 27	8 9 30 30	7 5 3 3	42 26 4	0.77952	9.891829	0.122385		R	idem
102	102	1799	Sep. 7 6 46 49	0 3 40 25	3 9 15 21	3 5 34 6	51 10 7	0.841456	9.925031	0.072582		R	idem
			7 4 34 20	0 3 36 4	3 9 33 38	3 5 57 34	50 52 27	0.83868	9.923596	0.071734		R	Méchain
			7 5 6 30	0 3 41 15	3 9 30 37	3 5 49 22	50 57 6	0.840003	9.924281	0.073707		R	idem
			7 5 43 25	0 3 39 10	3 9 27 19	3 5 48 9	50 57 30	0.840178	9.924372	0.073571		R	Zach
			7 5 59 57	0 3 38 16	3 9 23 3	3 5 44 47	51 2 27	0.840305	9.924434	0.073477		R	Wahl
103	103	1799	Dec.25 19 3 50	6 10 11 51	10 26 27 18	4 16 12 27	77 0 47	0.62445	9.795498	0.266884		R	Olbers
			25 18 13 7	6 10 22 46	10 26 39 18	4 16 7 34	77 5 4	0.624126	9.795182	0.266901		R	Wahl
			25 21 40 10	6 10 20 12	10 26 49 11	4 16 28 59	77 1 38	0.62580	9.796436	0.265474		R	Méchain
104	104	1801	Aug. 8 13 0 0	6 1 1	1 12 8	7 11 7	20 20	0.2490	9.396200	0.865828		R	idem
			8 13 32 0	6 3 49	1 14 28	7 10 39	21 20	0.2617	9.417804	0.833430		R	Burckhardt
105	105	1802	Sep. 9 20 43 14	11 2 7 45	10 10 16 46	0 21 50 59	57 0 20	1.09420	0.039295	9.901186		D	Méchain
			9 21 32 29	11 2 9 4	10 10 15 39	0 21 53 25	57 0 47	1.09417	0.039061	9.901537		D	Olbers
106	106	1804	Feb.13 14 16 16	4 28 44 51	5 26 47 58	11 1 56 53	56 28 40	1.07117	0.029858	9.915341		D	Gauss
			13 15 40 0	4 28 53 52	5 26 49 47	11 2 4 5	56 44 20	1.072277	0.030308	9.914666		D	Bouvard
			13 14 25 45	4 29 4 25	5 26 53 29	11 2 10 56	56 56 2	1.07501	0.031412	9.913010		D	Wahl
(86)	107	1805	Nov.18 3 18 27	4 27 51 28	11 14 37 19	5 13 11 9	15 36 30	0.37862	9.578201	0.592826		D	Bessel
			17 19 20 30	4 27 17 0	11 10 11 0	5 17 6 0	17 34 0	0.34649	9.53969	0.65050		D	Gauss
			18 0 25 0	4 23 0 28	11 15 6 56	5 13 53 32	15 58 12	0.37566	9.574758	0.597931		D	Legendre
			18 1 8 6	4 28 44 57	11 15 5 58	5 13 38 59	15 52 38	0.376286	9.575461	0.596987		D	Bouvard
			21 12 9 11	5 6 47 24	11 4 20 11	6 2 27 13	13 33 30	0.340421	9.5320165	0.6621085	0.84617529	D	Encke
107	108	1805	Dec.31 6 47 1	3 19 23 40	8 10 33 14	7 8 50 26	16 33 33	[illegible]	9.950248	0.032756		D	Gauss

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			h ′ ″	s ° ′ ″	s ° ′ ″	s ° ′ ″	° ′ ″						
107	108	1806	Jan. 2 10 35 10	3 19 30 2	8 11 28 23	7 8 1 39	12 43 10	0.911786	9.959893	0.020289		D	Gauss
		1805	Dec. 31 6 19 27	3 19 21 55	8 10 34 42	7 8 47 13	16 30 35	0.89203	9.950379	0.034560		D	Bessel
			31 18 39 36	3 19 23 13	8 10 48 5	7 8 35 8	15 36 10	0.89682	0.952702	0.031074	0.914307	D	idem
			31 6 51 8	3 19 23 39	8 10 33 34	7 8 50 5	16 31 10	0.89181	9.950270	0.034723		D	Legendre
			31 6 20 59	3 17 21 50	8 10 33 35	7 6 48 15	16 30 32	0.89193	9.950330	0.034633	0.6769242	D	Gauss
			31 8 41 18	3 19 28 54	8 10 31 34	7 8 57 20	16 35 9	0.891347	9.950047	0.034057		D	Bouvard
			31 5 46 43	3 19 23 29	8 10 33 20	7 8 50 9	16 31 27	0.8917974	9.9502662	0.0347290		D	idem
108	109	1806	Dec. 28 22 2 20	3 4 4 30	10 22 18 38	7 18 14 8	35 4 5	1.08193	0.034198	9.90883		R	Bessel
			28 22 30 43	3 7 2 3	10 22 19 15	7 15 17 12	35 2 50	1.081571	0.034055	9.909066		R	Burckhardt
109	110	1807	Sep. 18 18 56 0	9 0 56 53	8 26 39 40	0 4 17 13	63 14 1	0.647491	9.811234	0.243278		D	Bouvard
			18 19 6 0	9 1 0 13	8 26 38 31	0 4 21 42	63 12 36	0.64788	9.811493	0.242889		D	Gauss
			18 5 31 12	9 2 24 0	8 26 44 0	0 5 40 0	62 57 0	0.65320	9.8150	0.23763		D	Beck Calkoen
			18 19 49	9 0 53 38	8 26 29 25	0 4 24 13	63 16 15	0.647617	9.811316	0.243155		D	Brojelmann
			18 20 7 5	9 1 6 8	8 26 40 52	0 4 25 16	63 13 7	0.64846	9.811880	0.242298		D	Oriani
			18 15 15 51	9 0 51 5	8 26 42 12	0 4 8 53	63 12 51	0.646267	9.810412	0.244510		D	Ferrer
			18 17 38 50	9 0 48 1	8 26 39 9	0 4 5 52	63 12 30	0.646213	9.810376	0.244564		D	Lemeur
			18 11 44 26	9 0 5 55	8 26 40 26	0 3 25 29	63 27 14	0.646212	9.810376	0.244565		D	Triesnecker
			18 15 52 50	9 0 39 22	8 26 36 57	0 4 2 25	63 17 56	0.648123	9.811657	0.242643		D	Santini
			18 19 27 55	9 0 59 55	8 26 25 3	0 4 34 52	63 9 57	0.649620	9.812659	0.241140		D	Bowditch
			18 20 55 32	9 1 6 53	8 26 33 4	0 4 33 49	63 11 18	0.648769	9.812097	0.241983		D	Dam. de Montf
			18 19 3 0	9 0 58 22	8 26 40 46	0 4 17 36	63 13 2	0.64746	9.811216	0.243305		D	Cacciatore
			18 19 51 7	9 1 6 8	8 26 36 52	0 4 29 16	63 14 28	0.64896	9.812217	0.241803	0.99503175	D	Bessel
			18 17 41 43	9 0 53 51	8 26 48 9	0 4 5 45	63 10 11	0.64587	9.810147	0.244908		D	idem
			18 17 53 20	9 0 54 42	8 26 47 12	0 4 7 30	63 10 28	0.6461238	9.8103158	0.2446546	0.99518781	D	idem
110	111	1808	July 12 4 10 49	8 12 38 50	0 24 11 15	7 18 27 35	39 18 59	0.60786	9.783870	0.281323		D	idem
111	112	1810	Oct. 5 19 54 11	2 3 9 10	10 8 53 4	3 24 16 6	62 46 17	0.96914	9.986385	9.980551		D	idem
112	113	1811	Sep. 15 10	3 18 12 30	4 19 0	1 0 47 30	71 50	1.2337	0.05450	9.675378		R	Burckhardt
			12 9 54 21	2 14 48 14	4 20 20 25	2 5 32 11	73 9 40	1.035679	0.015225	9.937290		R	Bessel
			12 4 51 3	2 15 17 34	4 20 21 13	2 5 6 39	73 7 16	1.040061	0.017060	9.934539		R	Gauss
			10 0 21 9	2 13 14 35	4 21 4 59	2 7 50 24	73 48 2	0.98069	9.99153	9.972833		R	idem
			12 6 57 30	2 14 29 40	4 20 16 56	2 5 47 16	72 59 10	1.02716	0.011638	9.942672	0.9919532	R	Flaugergues
			12 6 2 31	2 15 1 9	4 20 24 30	2 5 23 21	73 2 36	1.0351090	0.0151120	9.9374603	0.9954056	R	Bessel

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				h ′ ″	s ° ′ ″	s ° ′ ″	s ° ′ ″	° ′ ″						
112	113	1811	Sep. 12	7 40 13	2 14 56 0	4 20 19 50	2 5 23 50	72 3 3	1.03483	0.0152885	9.937197		R	Bouvard
			12	6 0 23	2 15 1 44	4 20 21 58	2 5 20 14	73 4 31	1.03530	0.0151018	9.9374711		R	Nicolai
			12	9 19 1	2 14 51 58	4 20 23 18	2 5 31 20	73 3 44	1.03618	0.0151347	9.9369761		R	Piazzi
			12	9 15 18	2 14 54 24	4 20 23 46	2 5 29 22	73 3 23	1.0362	0.0151432	9.936963		R	Calandrelli
			12	5 2 21	2 15 4 43	4 20 21 40	2 5 16 57	73 4 18	1.036406	0.015530	9.936833		R	Gauss
			12	6 19 53	2 15 0 34	4 20 24 41	2 5 24 10	73 2 21	1.0354228	0.0151178	9.937451[illegible]	0.99509330	R	Argelander
			12	6 1 17	2 15 0 0	4 20 24 26	2 5 24 26	73 2 43	1.0355870	0.0151869	9.9373479	0.9950827	R	Conti
			12	8 37 6	2 14 55 6	4 20 24 41	2 5 29 35	73 4 48	1.036174	0.0151327	9.9369792		R	Oriani
113	114	1811	Nov. 9	5 52 47	1 16 10 50	3 2 57 1	10 13 13 49	31 29 28	1.58533	0.2001197	9.6549102		D	Werner
			11	4 46 1	1 17 32 10	3 2 53 9	10 14 39 1	31 32 53	1.58892	0.2011007	9.6584772		D	idem
			11	13 9 11	1 17 47 0	3 2 55 1	10 14 51 59	31 31 52	1.58963	0.2012978	9.6557831		D	idem
			11	2 45 9	1 17 29 30	3 2 56 13	10 14 33 17	31 29 14	1.58791	0.2008271	9.6588876		D	Zach
			11	4 30 17	1 17 32 0	3 2 54 34	10 14 37 26	31 30 57	1.588356	0.2009477	9.6587067		D	Nicolai
			10	23 55 39	1 17 27 27	3 3 1 52	10 14 25 35	31 17 11	1.582107	0.1992359	9.6622741	0.98271088	D	idem
			12	18 28 12	1 18 42 26	3 2 57 51	10 15 44 35	31 31 30	1.597347	0.2033933	9.6650383		D	Oriani
114	115	1812	Sep. 14	14 17 16	3 2 40 29	8 13 36 25	6 19 4 4	74 1 32	0.78212	9.8932745	0.1202165		D	Werner
			14	20 35 55	3 1 54 45	8 13 43 25	6 18 11 20	73 53 51	0.78830	9.8966903	0.1150919		D	idem
			15	0 0 0	3 2 54 38	8 13 18 50	6 19 35 48	74 20 30	0.77835	9.8911749	0.1232660		D	Nicollet
			15	15 53 14	3 2 39 53	8 13 40 46	6 18 59 7	73 57 3	0.782167	9.8932995	0.1201795		D	idem
			15	7 40 53	3 2 18 44	8 13 1 3	6 19 17 41	73 57 3	0.7771403	9.8904395	0.1243799	0.9545412	D	Encke
			16	6 39 48	3 5 3 4	8 13 53 14	6 21 9 50	75 7 15	0.781331	9.8928365	0.1208735		D	Oriani
115	116	1813	Mar. 5	16 46 0	2 6 52 30	2 17 27 30	0 10 35 0	27 33 30	0.67451	9.8289916	0.2166409		R	Werner
			4	12 45 4	2 9 57 29	2 0 35 55	11 20 38 26	21 9 49	0.699197	9.8445998	0.1932286		R	idem
			4	12 47 31	2 9 56 8	2 0 48 24	11 20 52 16	21 13 33	0.69933	9.8446822	0.1931050		R	Nicollet
116	117	1813	May 19	17 14 47	6 17 59 0	1 12 41 49	6 24 42 19	81 23 21	1.21740	0.0854318	9.8319765		R	Daussy
			19	12 22 32	6 17 37 6	1 12 40 21	6 25 3 15	81 1 0	1.21532	0.0846919	9.8330909		R	idem
			19	14 9 34	6 17 28 26	1 12 57 30	6 25 29 4	80 44 20	1.21433	0.0843362	9.8336249		R	Werner
			19	7 16 51	6 17 53 36	1 12 40 6	6 24 46 30	81 1 30	1.21760	0.0855046	9.8318714		R	Nicollet
			19	10 27 4	6 17 43 46	1 12 40 40	6 24 56 54	81 2 28	1.21610	0.084969	9.8326748		R	Encke
			19	10 14 53	6 17 43 8	1 12 40 15	6 24 57 7	81 2 12	1.215965	0.0849212	9.8327165		R	Gerling
117		1815	Apr. 25	2 53 5	4 27 3 38	2 22 45 21	2 4 18 17	44 52 10	1.23639	0.092156	9.821894		D	Bessel
			25	11 10 54	4 27 35 55	2 22 43 6	2 4 52 49	44 43 13	1.28024	0.08[illegible]	9.8251431		D	Gauss

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			h ′ ″	s ° ′ ″	s ° ′ ″	s ° ′ ″	° ′ ″						
117		1815	Apr. 25 3 56 25	4 27 4 42	2 22 47 54	2 4 16 48	44 52 40	1.23717	0.0924291	9.8214842		D	Encke
			25 23 51 0	4 28 58 48	2 23 26 21	2 5 32 27	44 30 43	1.21349	0.0840362	9.8340840	0.933149	D	Gausss
			26 1 9 56	4 29 2 58	2 23 26 50	2 5 36 8	44 30 45	1.21309	0.0838930	9.831288	0.9305435	D	Nicollet
			25 23 59 27	4 29 1 58	2 23 28 36	2 5 33 22	44 29 52	1.212941	0.0838369	9.8313729	0.9316693	D	Nicolai
			25 23 58 5	4 29 1 56	2 23 28 34	2 5 33 22	44 29 55	1.212869	0.0838109	9.8314119	0.93121968	D	Bessel
118		1818	Feb. 27 9 47 0	6 3 57 0	2 10 7 0	3 23 50 0	89 42 0	1.19725	0.078185	9.812851		D	Olbers
			26 6 0 0	6 2 56 52	2 10 21 10	3 22 35 42	89 47 27	1.19878	0.0787396	9.8120189		D	Nicollet
			26 21 4 17	6 3 22 58	2 10 5 2	3 23 17 56	90 0 0	1.20052	0.07937	9.811073		D	Gauss
			25 23 10 10	6 2 45 22	2 10 26 11	3 22 19 11	89 43 48	1.197761	0.0783711	9.8125716		D	Encke
119		1818	Dec. 5 0 0 0	11 28 8 16	2 29 55 14	3 1 46 58	63 10 30	0.85643	9.9326919	0.0610949		R	Nicollet
			4 2 19 23	11 27 0 24	3 0 7 29	3 3 7 5	62 40 50	0.8479	9.928321	0.0676123		R	Bessel
			4 22 35 18	11 28 4 51	2 29 59 53	3 1 55 2	63 5 29	0.855096	9.9320118	0.0621061		R	Rosenberg &
			5 0 56 11	11 28 13 20	3 0 0 51	3 1 47 31	63 0 24	0.854923	9.9319574	0.0621922	1.011617	R	Schercke
(86)		1819	Jan. 21 21 47 8	4 21 23 52	10 29 22 47	5 25 1 5	14 40 37	0.35310	9.54790	0.63828		D	Encke
			24 23 18 50	4 26 46 6	11 1 21 13	5 25 21 53	15 11 43	0.32963	9.51802	0.68310		D	idem
			21 23 8 0	4 21 52 12	10 29 4 33	5 25 47 39	14 47 42	0.352563	9.5472367	0.6392732		D	Nicollet
			27 2 39 27	5 6 14 8	11 4 18 8	6 1 56 0	13 42 30	0.335581	9.5257909	0.6614329	0.8567675	D	Encke
			27 6 3 4	5 7 5 53	11 4 43 37	6 2 22 16	13 38 42	0.333982	9.5237230	0.6745438	0.8190883	D	idem
120		1819	June 27 17 18 16	9 17 6 25	9 3 44 9	0 13 22 16	80 45 12	0.341256	9.5330800	0.6605083		D	Dirksen
			27 17 42 37	9 17 13 15	9 3 43 57	0 13 29 48	80 44 16	0.341956	9.5339701	0.6591731		D	Cacciatore
			27 17 19 16	9 17 2 38	9 3 43 33	0 13 19 5	80 45 26	0.341549	9.5331982	0.6603310		D	Sniadecki
			27 18 32 55	9 17 21 18	9 3 42 52	0 13 41 26	80 42 22	0.342989	9.53528	0.65721		D	Encke
			27 17 54 51	9 17 13 4	9 3 42 28	0 13 30 36	80 43 50	0.3420005	9.5340268	0.6590881		D	Nicolai
			27 17 20 24	9 17 5 54	9 3 42 52	0 13 23 2	80 44 44	0.341008	9.5327646	0.6609814		D	Bouvard
			27 11 1 22	9 17 5 5	9 3 43 44	0 13 21 21	80 45 53	0.341051	9.5328194	0.6608092		D	Brinkley
121		1819	July 20 16 20 0	9 2 34 56	3 19 56 47	5 12 38 9	11 53 15	0.71261	9.87076	0.15399		D	Carlini
			19 5 26 0	9 0 9 31	3 20 3 34	5 10 5 57	11 46 9	0.76285	9.88244	0.13647		D	Encke
			31 3 29 44	9 20 40 12	3 24 31 21	5 26 8 51	11 16 53	0.70008	9.84515	0.19240	0.60353	D	idem
			18 21 45 39	9 4 40 51	3 23 10 46	5 11 30 5	10 42 48	0.773638	9.8885378	0.1273216	0.75519035	D	idem
122		1819	Nov. 16 21 11 8	2 9 52 53	2 23 34 3	11 16 18 50	11 44 17	0.86744	9.93824	0.05277		D	Carlini
			21 1 7 48	2 11 23 44	2 20 57 29	11 20 26 15	10 56 13	0.87878	9.94388	0.01431		D	Encke
			20 6 2 55	2 7 18 48	2 17 13 57	11 20 4 51	9 1 16	0.892559	9.9506368	0.0341731	0.6867458	D	idem

N.	Delambre	Date.	Passage of the Perihelium in Parisian mean time.	Longitude of the Perihelium.	Longitude of the ascending node.	Angle between the Perihelium and the node.	Inclination.	Distance in the Perihelium.	Log. Dist. Perihelium.	Log. mean motion.	Eccentricity.	Direction	Name of the Computer.
			h ′ ″	s ° ′ ″	s ° ′ ″	s ° ′ ″	° ′ ″						
123		1821	Mar. 21 12 31 48	7 29 28 21	1 18 38 48	5 19 10 27	73 39 40	0.091808	8.96288	1.51581		R	Encke
			21 15 48 32	7 29 40 27	1 18 46 30	5 19 6 3	73 8 53	0.0927082	8.967118	1.509451		R	Bessel
			21 14 14 36	7 29 35 53	1 18 44 18	5 19 8 25	73 20 0	0.0922882	8.9651463	1.5124088		R	Rümker
			21 14 1 47	7 29 34 5	1 18 43 34	5 19 9 29	73 23 15	0.092185	8.96466	1.51314		R	Nicolai
			21 9 33 7	7 29 18 37	1 18 32 12	5 19 13 35	74 10 55	0.091113	8.95958	1.52076		R	Nicollet
			21 14 20 48	7 29 34 7	1 18 44 15	5 19 10 8	73 19 44	0.092172	8.9645990	1.5132298		R	v. Staudt
			21 7 23 8	8 0 35 8	1 19 38 17	5 19 3 9	74 32 41	0.089401	8.95134	1.53312		R	Brinkley
			21 11 21 9	7 29 30 33	1 18 42 18	5 19 11 45	73 34 53	0.091677	8.9622604	1.5167377		R	idem
			21 13 2 0	7 29 29 25	1 18 40 56	5 19 11 31	73 33 7	0.0918232	8.9629523	1.5156992		R	Rosenberger
124		1822	May 5 6 1 22	6 12 44 9	5 26 26 9	11 13 42 0	53 41 0	0.509472	9.70712	0.40695		R	Carlini
			5 7 49 9	6 11 43 16	5 26 35 58	11 14 52 42	53 36 7	0.512106	9.70936	0.39609		R	Ursinus
			5 5 51 13	6 12 42 30	5 26 38 51	11 13 56 24	53 33 0	0.504551	9.702905	0.4057708		R	Hansen
			5 15 5 11	6 12 48 45	5 27 30 50	11 14 42 5	53 34 3	0.504220	9.70262	0.406198		R	Nicollet
			5 12 45 31	6 12 45 34	5 27 22 26	11 14 36 52	53 36 12	0.504309	9.7026967	0.4060833		R	Gambart
			5 6 32 13	6 13 3 20	5 26 38 4	11 13 34 44	53 48 36	0.502736	9.70131	0.408118		R	Encke
			5 14 3 30	6 12 45 48	5 27 27 22	11 14 41 34	53 34 48	0.504429	9.70280	0.405928		R	idem
(86)		1822	May 23 23 51 52	5 7 11 29	11 4 19 32	6 2 51 57	13 22 25	0.345793	9.5388157	0.6519047	0.8145479	D	Encke
125		1822	Oct. 23 6 5 29	9 2 19 40	3 2 28 2	6 0 8 22	52 32 52	1.152975	0.06182	9.867398		R	Schnürlein
			23 8 18 14	9 2 10 55	3 2 25 7	6 0 14 12	52 30 55	1.151880	0.061390	9.868043		R	Argelander
			23 13 46 40	9 3 11 27	3 2 33 4	5 29 21 37	52 36 22	1.148694	0.0602033	9.8698233		R	Gambart
			23 15 22 43	9 1 47 52	3 2 43 58	6 0 56 6	52 39 48	1.14612	0.05923	9.871283		R	Nicolai
			23 15 15 48	9 1 48 9	3 2 43 47	6 0 55 38	52 39 6	1.146357	0.05932	9.871148		R	idem
			23 7 20 26	9 2 13 2	3 2 26 2	6 0 13 0	52 30 15	1.151870	0.0614036	9.8680229		R	Hansen
			23 13 20 48	9 1 53 32	3 2 38 18	6 0 44 46	52 36 52	1.147602	0.0597898	9.8704436		R	idem
			23 15 11 19	9 1 48 12	3 2 42 32	6 0 54 20	52 39 11	1.146401	0.0593361	9.8711237		R	idem
			24 23 17 24	9 0 31 41	3 3 5 3	6 2 33 22	52 39 42	1.133710	0.0545019	9.8783754	0 96617805	R	Encke
			23 23 4 9	9 1 29 56	3 2 47 31	6 1 17 35	52 39 7	1.1433092	0.0581979	6.8728314	0.99117685	R	idem

iii. *Copy of a Report to the Board of Customs, containing a description of an improved* SLIDING RULE *for* GAUGING *Casks.*

Sir,

IN the Report which I addressed to you a few months since, stating my opinion of Mr. Watts's proposals for the improvement of gauging, I promised to send some further observations for the consideration of the Board of Customs, as soon as the legislature should have come to a decision respecting the alterations which have been proposed in the system of weights and measures; and though it seems that the wine gallon must remain for the present in use, yet as there is every reason to imagine that an imperial gallon, exactly one fifth larger, will ultimately be adopted, it might be right to suspend the introduction of any new instruments into general use, until the proposed regulations shall have been more fully appreciated by the House of Lords, and to ascertain in the mean time how far the instrument, which I have the honour to present to the Board, is likely to fulfil the purposes for which I have constructed it, that is, for determining, upon principles which are entirely new, and with the greatest possible simplicity and expedition, the approximate content of any cask whatever, subject to any further corrections which either theory or experience may dictate in particular cases.

My sliding rule contains four graduated lines, marked, BUNG DIAMETER IN INCHES AND TENTHS, HEAD DIAMETER, LENGTH, and CONTENT IN GALLONS.

The computation is performed by merely bringing the head diameter of the given cask to the bung, on the respective lines; the content may then be read off opposite to the length of the cask.

The degree of accuracy of the result may be inferred from the contents of twenty-one casks, as very carefully determined by Mr. Watts, at my suggestion, and by order of the Board.

No.	Bung	Head	Length	(Wake)	Content by weight	Sliding Rule	Error
I.	30.0	21.8	46.8	1.3	115.3	116.3	+ 1.0
II.	28.6	21.7	47.0	1.4	108.0	109.4	+ 1.4
III.	31.7	22.9	50.1	1.7	141.2	138.3	− 2.9

No.	Bung	Head	Length	(Wake)	Content by weight	Sliding Rule	Error
IV.	31.4	26.6	46.4	0.4	137.4	139.4	+ 2.0
V.	32.6	24.5	44.2	1.4	131.7	132.3	+ 0.6
VI.	32.3	24.4	48.5	0.4	142.5	143.2	+ 0.7
VII.	29.4	25.3	45.8	0.3	122.4	121.9	− 0.5
VIII.	32.7	26.3	42.4	1.1	133.5	133.6	+ 0.1
IX.	28.6	22.4	48.5	1.0	114.7	115.0	+ 0.3
X.	32.4	26.8	35.9	0.9	112.8	113.1	+ 0.3
XI.	39.8	33.0	51.9	1.0	248.0	247.2	− 0.8
1	30.6	26.1	45.8	0.4	130.8	131.4	+ 0.6
2	30.9	26.0	47.2	0.2	136.8	136.6	+ 0.2
3	29.1	23.1	48.8	0.2	120.9	120.8	− 0.1
4	31.2	26.4	45.4	0.3	134.7	134.4	− 0.3
5	32.7	26.0	43.1	0.6	133.8	134.7	+ 0.9
6	32.3	27.9	34.6	0.4	110.0	111.4	+ 1.4
7	32.1	27.5	35.3	0.3	110.0	111.6	+ 1.6
8	29.5	21.7	47.1	1.5	116.0	114.1	− 1.9
9	31.5	23.2	50.1	2.1	140.7	138.2	− 2.5
10	29.7	25.3	47.3	0.2	125.8	128.0	+ 2.2

It appears from this table that the error of the sliding rule is less than a gallon in twelve out of the twenty-one pipes, and that it never amounts to three gallons, including the effect of whatever accidental irregularities there may have been in the form of the staves. The whole sum of the errors, for the twenty-one pipes, amounts to twenty-two gallons: the errors of the common mode of computing amount to twenty-six, with all the allowances made by the most experienced gaugers: so that by one simple operation, the new sliding rule gives at once a result at least as correct, as the best methods now in use by two or three; and this result remains susceptible of correction, by any further computations that may be thought necessary.

It may be proper, if great accuracy in the result be required, and be thought attainable, that a table of corrections should hereafter be computed which would be entered with the difference of the bung and head diameters, and also with the "wake," that is, as I have already applied the term in a former communication, the

fall of the bung below a line touching the staves at the head. The rule itself gives a perfectly correct result in casks that differ but little from a cylinder; and it may be observed in the IIId and IVth examples, that a great wake appears to require some little addition to be made to the content, and a small wake some subtraction: and the casks 8 and 9, compared with 10, will also serve to indicate the propriety of a similar correction. I shall explain, in a separate note, the principles on which such a computation may be made, if required; but I am not confident, from the result of all the cases I have examined, that the advantage of these minute corrections would not be perfectly inconsiderable, in comparison with the unavoidable irregularities of the forms of the casks, and the probable errors in their admeasurement; especially as in any large number of casks that are to be gauged at the same time, the errors of the different casks being most commonly divided between the opposite sides of the truth, would have a general tendency to neutralise each other.

On the whole, therefore, I have reason to believe that the new sliding rule alone will be found quite as accurate as can be required for the ordinary purposes of the revenue, and that the simplicity of its operation will be found to save much time and labour, and to avoid all chance of error in computation; and I trust that the Board of Customs will be pleased to order some of its officers to make trial of it in their practice on a large scale.

I have the honour to be,

Sir,

Your obedient humble servant,

THOMAS YOUNG.

P. Delavaud, Esq.,
&c. &c. &c.

NOTE on the new Sliding Rule.

The formula represented by the sliding rule is this, $\frac{203}{150}$ Log. B $+ \frac{97}{150}$ Log. H + Log. L − Log. $\left\{\frac{294 \text{ W.G}}{353 \text{ I.G}}\right\}$ = Log. Content: or otherwise $B^{1.3533} \times H^{.6467} \times L : 294 =$ Content. The

different lines are therefore laid down from three different logarithmic scales, such that the distance from 1 to 2 on the line B is to the distance from 1 to 2 on the lines L and C, as $\frac{203}{350}$ to 1, the similar distance on the line H being only $\frac{97}{150}$ as great; the sum of these distances on the lines B and H amounting to $\frac{300}{150}$; so that if B and H were equal, this sum would represent their square, as it obviously ought to do, while in other cases it would approach very near to the square of a mean diameter equal to $H + \frac{2}{3}$ $(B - H)$.

The same result might also be obtained from a table constructed according to this formula as from the rule, adding together the logarithm of B, H, and L, that of 294 being previously subtracted throughout from the numbers of one of the former columns, so that the third might serve both for L and for C.

Table for graduating the Sliding Rule.

Inches	I. B.	II. H.	III. L. IV. C.	Inches	I. B.	II. H.	III. L. IV. C.
10.0		0.000		22.0	[illegible]3.830	16.359	3.057
.5		1.012		.5	14.803	16.825	3.779
11.0		1.978		23.0	15.761	17.281	4.484
.5		2.900		.5	16.695	17.728	5.199
12.0		3.783		24.0	17.609	18.165	5.850
.5		4.625		.5	18.505	18.093	6.536
13.0		5.443		25.0	19.382	19.011	7.159
.5		6.225		.5	20.242	19.420	7.794
14.0		6.980		26.0	21.085	19.825	8.417
.5		7.709		.5	21.913	20.221	9.029
15.0		8.412		27.0	22.724	20.608	9.627
.5		9.092		.5	23.521	20.990	10.192
16.0	0.000	9.752		28.0	24.304	21.363	10.795
.5	1.336	1[illegible]390		.5	25.072	21.730	11.362
17.0	2.633	11.008		29.0	25.828	22.086	11.922
.5	3.892	11.611		.5	26.570	22.445	12.469
18.0	5.115	12.193		30.0	27.300	22.794	13.008
.5	6.305	12.764		.5	28.018	23.138	13.539
19.0	7.463	13.316		31.0	28.724	23.475	14.060
.5	8.591	13.856		.5	29.419	23.806	14.574
20.0	9.691	14.381	0.000	32.0	30.103	24.133	15.079
.5	10.763	14.897	0.791	.5	30.776	24.455	15.576
21.0	11.810	15.394	1.565	33.0	31.439	24.772	16.066
.5	12.832	15.886	2.320	.5	32.092	25.083	16.548

Inches	I. B.	II. H.	III. L. IV. C.	Inches	I. B.	II. H.	III. L. IV. C.
34.0	32.736	25.392	17.027	57.0			33.601
.5	33.370	25.694	17.517	.5			33.882
35.0	33.995	25.993	17.929	58.0			34.159
.5	34.611	26.286	18.412	.5			34.435
36.0	35.218	26.577	18.863	59.0			34.708
.5	35.817	26.863	19.300	.5			34.979
37.0	36.408	27.145	19.736	60.0			35.247
.5	36.991	27.424	20.167	.5			35.514
38.0	37.566	27.699	20.592	61.0			35.775
.5	38.134	27.970	21.012	.5			36.040
39.0	38.694	28.238	21.426	62.0			36.299
.5	39.248	28.502	21.835	.5			36.557
40.0	39.794	28.763	22.236	63.0			36.812
.5	40.334	29.021	22.637	.5			37.065
41.0	40.866	29.275	23.029	64.0			37.318
.5	41.393	29.527	23.420	.5			37.567
42.0	41.913	29.776	23.806	65.0			37.815
.5	42.427	30.021	24.183	.5			38.061
43.0	42.935	30.264	24.559	66.0			38.329
.5	43.437	30.504	24.932	.5			38.547
44.0	43.933	30.741	25.296	6[illegible]0			38.789
.5	44.424	30.975	25.658	.5			39.026
45.0	44.909	31.207	26.017	68.0			39.263
.5			26.371	.5			39.498
46.0			26.722	69.0			39.731
.5			27.069	.5			39.960
47.0			27.412	70.0			40.193
.5			27.707	.5			40.421
48.0			28.083	71.0			40.648
.5			28.420	.5			40.873
49.0			28.750	72.0			41.096
.5			29.075	.5			41.319
50.0			29.398	73.0			41.539
.5			29.717	.5			41.758
51.0			30.033	74.0			41.975
.5			30.346	.5			42.192
52.0			30.655	75.0			42.406
.5			30.963	.5			42.619
53.0			31.267	76.0			42.831
.5			31.568	.5			43.066
54.0			31.869	77.0			43.251
.5			32.162	.5			43.458
55.0			32.455	78.0			43.689
.5			32.746	.5			43.870
56.0			33.034	79.0			44.073
.5			33.319	.5			44.276
				80.0			44.4[illegible]

The first three lines may begin from any given points; the fourth must be so placed that when B 28 and H 28 are brought together, L 30 may stand exactly against C 80.

Mode of computing the content of a Cask from the WAKE.

The *wake* is the drop of the bung below the cone touching the cask at the head, or half the difference between the bung diameter and that of the base of a cone in which the half cask is inscribed, so as to touch it exactly at the head. This element may be measured without much difficulty by means of a straight rod, with two fixed nails, of equal length, projecting from it near one end, and a third nail sliding along it, so as to stand over the bung when the former two are pressed down upon the stave between the hoops at the head, while the distance of its point from the bung is measured by a scale, or by a pair of compasses.

The direction of the surface of the staves being given in three given points through which it passes, we shall only have to assume that the curvature varies in a uniform manner, from its greatest magnitude at the bung, to its least magnitude at the head, in order to obtain a form which must very nearly coincide with the whole outline of the staves. The most convenient supposition respecting the curve is that it is of the nature of a parabola, either of an order inferior to the common parabola, and beginning at the bung, or of a higher order, beginning at the head, and meeting its companion at the bung in a direction parallel to the axis; and the latter form will be found, on examination, to be the most applicable to practical cases, the former approaching too much to a cone.

Now in all parabolas, when the ordinate is ax^n, the distance of the tangent from the curve, on the axis, or, in other words, the wake of the cask, is $(n-1)\,ax^n$; since the fluxion of the ordinate is $nax^{n-1}\,dx$, and, as dx is to this, so is the absciss x to nax^n, the sum of the ordinate, and of the distance in question; and making this distance $= k$, the ordinate being here $\frac{b-h}{2}$ we have $ax^n = \frac{b-h}{2}$: while $(n-1)\,ax^n = k$; consequently $n-1 = \frac{2k}{bh}$; or, if $b-h$

$= d$, $n - 1 = \frac{2k}{d}$, and $n = 1 + \frac{2k}{d} = \frac{d + 2k}{d}$. On the other hand, for a parabola having its vertex at the head, the wake becomes the ordinate, and $\frac{d}{2}$ assumes its place, so that n, or rather m, will be $1 + \frac{d}{2k} = \frac{d + 2k}{2k}$.

For the inferior parabola, the diameter of the cask, at the distance x from the middle, is always $b - ax^n$; its square $b^2 - 2abx^n + a^2x^{2n}$, and the content, considering the section as a square, $bx - \frac{2}{n+1} abx^{n+1} + \frac{1}{2n+1} a^2x^{2n+1}$; but when $x = \frac{l}{2}$, $ax^n = a\left(\frac{l}{2}\right)^n = d$, and we have, for the whole content, $2\left(b^2 \frac{l}{2} - \frac{2}{n+1} bd \frac{l}{2} + \frac{1}{2n+1} d \frac{l}{2}\right) = l\left(b^2 - \frac{2}{n+1} bd + \frac{1}{2n+1} d^2\right)$ $= l\left(b^2 - \frac{d}{d+k} bd + \frac{d}{4k+3} d^2\right)$.

For the superior parabola, the diameter, at the distance x from the head, is $h + cx - ex^m$; c being such, that $c \frac{l}{2}$ may be equal to $d + 2k$, and $e\left(\frac{l}{2}\right)^m$ being $= 2k$. Then the square of the diameter will be $h^2 + 2chx + c^2x^2 - 2ehx^m - 2cex^{m+1} + e^2x^{2m}$, and the content $h^2x + chx^2 + \frac{1}{3} c^2x^3 - \frac{2}{m+1} ehx^{m+1} - \frac{2}{m+2} cex^{m+2} + \frac{1}{2m+1} e^2x^{2m+1}$; which, for the whole length, becomes $l\left(h^2 + \frac{1}{2} chl + \frac{1}{12} c^2l^2 - \frac{2}{m+1} ch\left(\frac{l}{2}\right)^m - \frac{2}{m+2} ce\left(\frac{l}{2}\right)^{m+1} + \frac{1}{2n+1} e^2\left(\frac{l}{2}\right)^{2m}\right) = l\left(h^2 + (d+2k)h + \frac{1}{3}(d+2k)^2 - \frac{4}{m+1} hk - \frac{4}{m+2}(d+2k)k + \frac{4}{2m+1} k^2\right) =$

$$l\left(h^2 + (d + 2k)\,h + \frac{1}{3}(d + 2k)^2 + \frac{4k}{d + 3k}\,k^2 - \frac{8k}{d + 4k}\,hk - \frac{8k}{d + 6k}\,(d + 2k)\,k\right).$$

iv. *Remarks on* Professor Struve's *Observations to determine the Parallax of the fixed Stars. By* J. Pond, Esq., Astr. Royal.

Of the various attempts to discover the parallax of the fixed stars, the observations of Professor Struve must be regarded as among the best and most judicious. [*Obs.* Vol. II. III.]

His object is, by means of an excellent transit instrument furnished with seven wires, to determine the sum of the parallaxes of several fixed stars, differing nearly 12 hours in right ascension from each other.

The results which he obtains seem to verify a remark which I have often had occasion to make; that in proportion as any improvement takes place either in our instruments or our processes the resulting parallax becomes proportionally less.

Of fourteen sets of opposite stars thus compared, Mr. Struve finds seven, which give the parallax *negative;* this circumstance alone should suggest great caution in attributing to the effects of parallax the small positive quantities that are derived from the remaining seven. Mr. Struve however is inclined to assign 0″.16 of space as the parallax of δ Ursæ Minoris, and 0″.45 for the sum of the parallaxes of α Cygni, and ι Ursæ Majoris. His learned coadjutor, M. Walbeck, who, it appears, has undertaken the calculations, is disposed to attribute the greatest portion of this parallax to the smaller star; a circumstance so improbable requires very strong evidence for its support.

But whatever reasonable doubt we may entertain as to* any one given result relating to such extremely minute quantities, yet the mean of the whole must be admitted to deserve very great confidence; and it is to this view of the subject (omitted by the learned author,) that I wish to direct the attention of Astronomers.

* It should be remembered, that in a series of observations, it generally happens that some results will be erroneous by a greater quantity than the mean probable error.

If we take the mean of the fourteen results as relating generally to stars from the 1st to the 4th magnitude, it will appear that the mean sum of the parallaxes of two opposite stars is equal to 0″.036 of space, or the parallax of a single star equal to 0″.018.

If any reliance can be placed on these observations, every attempt to determine the parallax of these stars in declination must be entirely hopeless; since in this case we can only measure the shorter axis of the Ellipse, and the uncertainty of refraction must amount, at least, to twenty times the quantity we are in search of.

V. *An account of some Parhelia seen at the Cape of Good Hope. By the* Rev. Fearon Fallows, A. M.

June 21, 1823,
Cape Town.

My dear Sir,

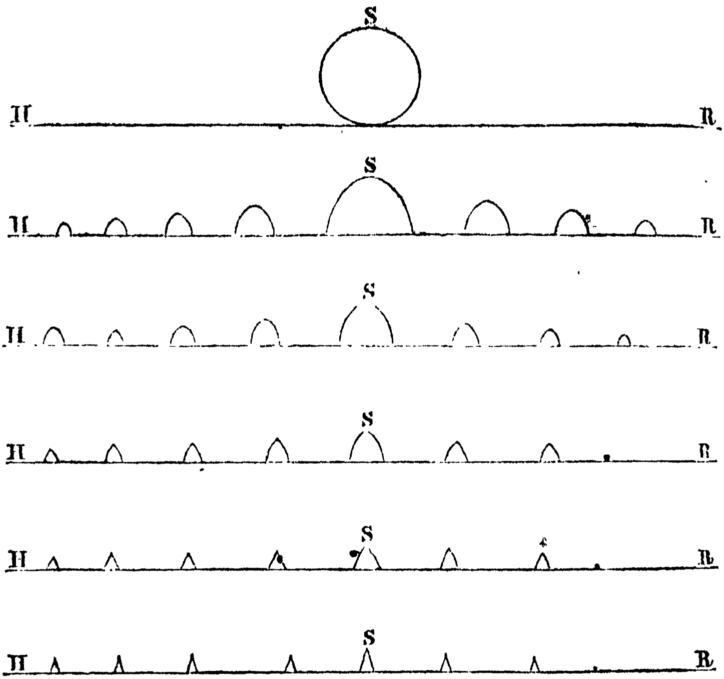
If you think the following worthy of insertion in any Scientific Journal, it is at the Editor's service.

I am, my dear Sir,
Yours most truly,
F. Fallows.

To Dr. T. Young,
&c. &c. &c.

Wednesday Evening, May 7, 1823.—During my ride this evening toward Seapoint, I was favoured with a most beautiful sight at sunset. The sky was delightfully clear;—not a cloud was visible, and the sea horizon remarkably distinct. When the sun's lower limb had just dipped the water-edge, immediately several parhelia made their appearance,—four on the left hand, and three on the right. They assumed the same shape as the real sun, and were as bright, but not so large. When the upper limb of the sun came in contact with the horizon, it, and the mock suns, appeared as bright points upon the water edge, and then, in an instant, all vanished together. Upon my return home, I made a diagram of this phenomenon, as seen at short intervals after each other, a copy of which (in preference to a minute description,) I beg here to subjoin.

H R the horizon, S the real sun. The remaining figures upon H R are the mock suns. Bar. 30.2 inches. Ther. 64 inches.



The morning of the 8th of May was cloudy, and indicated rain, quite contrary to what might have been expected from the clearness of the preceding evening.

N. B. On the *evening of the 8th*, we had a great deal of *thunder* and *lightning*.

Note by Dr. Young. There is every reason to suppose that these parhelia must in reality have been only fragments of coronæ, formed by the diffraction of a cloud rising but little above the horizon: the absence of colours may easily have depended on the absorption of all the light, except the red, in its long passage through a hazy atmosphere. I have seen a rainbow at sunrise, or rather a little before sunrise, in which no other colour whatever but red was perceptible.

vi. *Error in* Taylor's Logarithms.

Cosine of 37° 29′ 2″, for 5503, read 5603. H. J.

Art. XVIII.—MISCELLANEOUS INTELLIGENCE.

I. Mechanical Science.

1. *Experiment on the tenacity of Iron Wire, by* Colonel Dufour.—The extreme economy and facility of construction of wire bridges* are circumstances which cannot but tend to introduce them into very general use: hence a knowledge of the strength of iron wire as generally prepared by the manufacturers, and the circumstances which have an influence over it, cannot but possess great interest. The following experiments by M. Dufour, being made with a practical view, are, therefore, very valuable, and have already assisted in furnishing data for the construction of two wire bridges across the fortification ditch of Geneva.

The object of the experiments were to determine the absolute strength of wires of different diameters; their elongation when sustaining a given weight; the effects of a sudden concussion; the influence of annealing at a red heat, and the effect of a fold, or return, or junction of the wire, in determining rupture when in these circumstances.

Four kinds of iron wire were chosen, having the respective diameters of 1, 2, 3, and 4 millimetres nearly. Six experiments on the finest wire, of which the diameter was 0.85, mm. (0.033 of an inch,) proved that the strength was independent of the length; that the mean absolute force of such a wire was 106lbs. avoirdupois, the extremes being 103.7 and 120; and that when annealed, it sustained only 46.3lbs. Ten experiments on the second wire diameter 1.9 mm. or 0.748 of an inch gave 432.5lbs as the mean weight it could sustain, the extremes being 397 and 457; from which it would appear that the first wire had a seventh more of strength in proportion to its diameter than the second. The second wire, when annealed, sustained only 223lbs., which is to its strength when unannealed, as 100 to 194. The third wire about .118 of an inch in diameter, sustained as the mean of six experiments 843lbs.: when annealed its strength was to that of the unannealed wire, as 100 to 195. The fourth wire, of a diameter of .145 of an inch, supported 1713lbs. when unannealed, and 889lbs. when annealed, the ratio in the two states being as 100 to 192.

From these experiments Colonel Dufour concludes that iron wires from 1 to 4 millimetres in diameter, support at least 132lbs. for each square millimetre of their section. But according to known experiments on forged bars of iron, it has been ascertained, that those which are not more than 6 mm. square, do not support more than from 88 to 100lbs. per square millemetre, and those which are larger only from 55 to 66lbs., a circumstance which sufficiently proves the

* See Vol. XV. pp. 136—378 of this Journal.

advantage of employing iron drawn into wires, rather than forged into bars, when the question relates to its tenacity.

The second object of the experiments was to ascertain the elongation of a wire when submitted to a weight, less than that sufficient to break it. The elongation due to the mere rectification of the sinuosities and curves in the wire itself, was found to be $\frac{45}{1000}$ of the original length, when a bundle of twelve wires of the second kind before referred to and 30 feet long, was charged with a weight of 6621lbs. Another kind of elongation immediately precedes the rupture, and is due to a slight diminution of diameter. It may be perceived when the wire is charged with two-thirds of the weight, it is capable of supporting; and varies between 35 and 57 ten-thousandths of the length. When the wire is annealed the elongation is very considerable, and about thirteen-hundredths of the total length in all the wires tried.

The influence of folds, returns, &c., on the tenacity of the wire was of great importance considering the object of the experiments: the following are some of the practical results obtained. When a wire is passed round a ring or cylinder, so as to return parallel to itself, and bear a force applied to the two extremities nearly double that supported by the single wire, it requires that the diameter of the cylinder round which it passes should be at least $1\frac{1}{2}$ inches. In proportion as the diameter is smaller, or the curvature of the wire greater, its tenacity diminishes, and the wire will constantly break at that place. One or more entire revolutions of the wire on the same cylinder must be avoided, because the friction resulting from such an arrangement, opposes the equality of stress which is required upon each of the several wires constituting a bundle.

After many experiments on the different means of joining wires together, experience pointed out as the most efficient, one which would perhaps not have been indicated by theory. The method was to lay the ends side by side one over the other, and bind them round for the space of at least $1\frac{1}{4}$ of an inch, by a smaller annealed iron wire. Such a junction always resisted the proofs applied, the wires constantly giving way at some other place.

The preceding experiments were made with weights gradually accumulating, and unaccompanied by any sudden impulse or momentum, but as in their application to the construction of bridges, effects of the latter kind, would be continually occurring, further experiments were made of this nature. The wires were therefore charged with about half the entire weight they were able to support, and then other weights dropped from different heights into the box containing the previous charge. The latter force was always estimated by its momentum, and experiment proved that the second wire, for instance, charged with half the weight it was just able to bear, could sustain without risk a quantity of momentum equivalent to 3000, the weight being given in killograms (2.207lbs.) and the velocity by the centemetres traversed in a second.

Other experiments were made with reference to the effect of temperature on the tenacity of the wire, but for results of this kind, we refer our readers to p. 373, vol. xv., of this Journal: the results there stated are the same as those quoted with the above.—*Bib. Univ.* xxiii. 305.

2. *Suspension Bridge of Iron Wire at Geneva.*—The preceding researches have been applied with the greatest success, in the construction of two bridges across the dry ditches of the fortifications of Geneva. The first of these ditches is 33 feet deep and 108 feet wide at the site of the bridge; the second is 22 feet deep and 77 feet wide; they are separated by what is called the countergard, which is about 70 feet wide, and the top of which is level with the surrounding soil. A stone building is erected on the city edge of the first ditch, which serves as a point of attachment for the wires, as a gate to the city, and also as a station for the persons who have charge of the bridge; a piece of masonry is erected on the countergard, as a point of support for both bridges; and a third erection of a similar kind, serves as an outer gate, and for a support to the end of the outer bridge. The wire used is of the kind called No. 14 in commerce, very nearly of the diameter of the second sort referred to in the preceding experiments; it is made up into lengths or bundles, each containing 100 wires, and there are three such collections on each side of the bridge. As the line of suspension proceeds uninterruptedly across both ditches and the intervening bank, the length was found too great for one bundle; they were therefore made in shorter lengths, terminating at each end with a ring, and were connected by placing these rings side by side, and passing a strong iron bolt through them. Each single wire was first stretched by a weight of 220lbs., then made up into the bundles of 100 each, which were united by iron ties at successive intervals, and the whole rolled round with iron wire, which gives to them the appearance of cords. The longest of these bundles are 120 feet each, the others were made shorter, as being more convenient for the situation they would occupy in the line of suspension. From this arrangement it is evident that each of the six main lines of suspension may be considered as one bundle, though consisting of many parts; they are made fast at one extremity to a plate of iron firmly attached to the stone gate before mentioned, then pass over the first ditch, across the stone support on the countergard, over the second ditch, over the second standard, and are finally made fast to iron bars, which being attached to plates, are loaded with masses of stone and buried in the earth.

From the six principal lines other lines descend consisting each of twelve wires only; these are made fast to the traverses, or pieces of wood which form the bases of the bridges. On these are mortised long pieces of carpentry, which are bolted together with them, and to which are fastened the railings of the bridges, and then other planks are fastened across these again, forming the path of the bridge.

The rapid and complete success of this undertaking, does great

honour to M. Dufour. It was not quite finished at the time when M. Pictet wrote his account of it, but would be completed in a few days more. It had been planned and executed in the short space of six months. Its expense was previously extimated at 16,000 francs, and the cost amounted to within one or two hundred francs of that sum. This accuracy of estimation is not the least merit of M. Dufour, the engineer. The expectations with regard to the duration of the bridges are all in their favour; the iron is defended from rust by a thick coat of paint, which is to be renewed when required; the wood-work is of select materials, and not being any where in contact with the earth is not liable to rot.

Before constructing the large bridges, a model was made 38 feet long, and having only two suspending lines each composed of 12 wires of .073 of an inch in diameter. The foot-way was constructed on 11 wooden traverses, which hung from the suspension lines each by only four single wires, two at each end. This bridge was submitted to the roughest trials on the part of those persons who were curious to examine it, such as leaping, marching, *&c.*, but without the least accident or failure.—*Bib. Univ.* xxiii. 305.

3. *Hydraulic Experiments on the Propagation of Waves, by* M. Bidone *of Turin.*—The following is the translation of an extract made by M. Hachette, and inserted in the proceedings of the Philomatic Society. M. Bidone proposed to compare the results of experiments on the propagation of waves, with those deduced from the theory published by M. Poisson, in the *Mémoires of the Academy* 1816. This theory supposed that the waves were produced by a solid segment of a given figure slightly immersed in the fluid, and which after having allowed time for the fluid to assume a state of repose, is suddenly withdrawn in a vertical direction.

M. Bidone observes, that the body rapidly withdrawn, is followed by a column of water which rises above the level, and produces on descending, waves which are propagated in the same time with the primitive waves. Two causes concur in this elevation of the column of water, the pressure of the atmosphere, and the adhesion of the fluid particles to each other and to the body immersed. The height, the volume, and form of the column, depend on the figure of the segment immersed, and principally on the rapidity with which it is withdrawn. M. Bidone mentions many examples of raised columns of water, obtained by plunging successively a cone, a paraboloide of revolution, a cylinder and hemispheres, but his principal object being to produce undulations due to the cavity of the plunged segment, and the mere action of gravity, and to approach as nearly as possible to the hypothesis of M. Poisson, he has observed the primitive waves propagated at the surface of the liquid, at the instant when the removal of the body from the water commenced. The time which intervenes before the adhering column of water begins to fall, is more or less according to the height and figure of the column. When the

immersed body is not withdrawn rapidly, but slowly, the waves are not produced, but at the instant when the body is detached from the water.

The duration of the experiments on the primitive waves varied from one to six seconds; and the results were found by M. Bidone to accord with the theory of M. Poisson, when such experiments could be made, as satisfied the conditions serving as a foundation for the theory. M. Bidone terminates his memoir by remarks on the figure of waves obtained by striking the surface of water with prismatic segments, having triangular, square, and elliptical bases; they present phenomena similar to those exhibited by apertures, with their edges of the same forms. On comparing, for example, the square base of the prismatic segment to the wave formed by this segment, it was seen that the wave had the form of a quadrangle with rounded angles, and that the summits of the angles of the square base corresponded to the middle of the sides of the quadrangle.

The first part of the memoir of M. Bidone contains a verification of a formula, given by M. Eytelwein of Berlin, for calculating the velocity of water in a rectilinear canal; the section of the current and its perimeter, and the inclination of the canal taken at the upper surface of the water, or at the bottom of the canal parallel to that surface, being known. The accordance between the velocities observed and calculated according to the formula is remarkable. The difference is at most, only a forty-eighth of the first quantity.

4. *On a Phenomena of Shadows, by* M. Mongez.—When the sun is free from clouds, the shadow of bodies is surrounded by a penumbra, very sensible, though much more obscure than the shadow; when two bodies, each producing a shadow, are made to approach each other, at the moment preceding the contact the shadows advance towards each other, and change their form at the point of contact; the shadow of a right line thus becomes a curve, and that of a globe like the summit of a paraboloid. M. Arago attributes the effect to the superposition of the penumbras, accompanying the bodies; thus if the intensity of the penumbras was only half that of the shadow, it would be doubled at the instant when the two were superposed, and thus produce an obscure part of equal depth with the shadow, which being added to it, would alter its form in that place.—*Bib. Univ.* xxiii. 323.

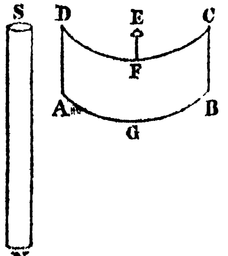
5. *On the Vibration of Air.*—M. F. Savart has published a variety of experimental researches into the nature of the vibrations performed by air, both in tubes and also in spaces of irregular form, but bounded by solid bodies; the latter are entirely new, and, with the former, possess great interest to those who delight in this branch of science. We cannot give a better idea of the nature of these results than by

quoting the conclusion of the memoir of M. Savart. The memoir itself is long, and will probably engage our attention again at a future time, in the progress of foreign science.

" *It results from these researches that masses of air, limited at every point of their extent, or even only at part of their extent, can enter into a state of vibration by communication, like those which are contained in tubes; and that when one is in an apartment where a sound is produced, one is, as it were, in a large organ-pipe, where the sonorous vibrations encountering each other, without doubt, in various directions, form centres of vibration and nodal surfaces, of which the form and direction vary almost infinitely, according to the form of the place where the phenomenon occurs, and according to its extent and the position of the different bodies which the vibrations may meet with, and which by themselves may, either by acting as vibrating bodies or not, influence the position of the vibrating parts and the intensity of the motion; for it is almost always observed in the spaces of which we speak, that there are parts of the mass of air often of a very small extent where the motion is incomparably stronger than elsewhere. Nevertheless the irregularity in the distribution of the vibrating parts is not observed except in places, furnished, or of an irregular form; for in other places, and especially in long galleries, the vibrating zones appear to exist generally and regularly.*"—*Ann. de Chimie*, xxiv. 56.

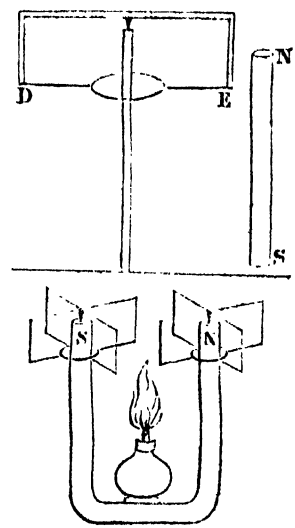
II. Chemical Science.

1. *Thermo-electric Rotation, by* Professor Cumming.—The following is an apparatus for the exhibition of thermo-magnetic rotation, invented by Professor Cumming, and described by him in a letter to the Editor of the *Annals of Philosophy*, N.S. vi. 436. A B platina, B C F D A silver, these are made into a parallelogram, which is afterwards bent into a semicircular form. F E is a wire less than the radius of the curve, proceeding horizontally from the frame, and E is an agate cap by which the instrument may be suspended freely on a point. A lamp and magnet being placed opposite to each other are sufficient to produce rotation, but the effect is improved by adding another magnet at 90° from the first, having its poles in the contrary direction, and being connected with it by a bar of soft iron placed beneath them. With this arrangement the rotation will be from right to left, or from left to right, according to the position of



the lamp. The second magnet is placed near F G, having its N end upwards. If the lamp be beneath B, the rotation is in the direction B G A; but if it be opposite to F G, the rotation is A G B. The apparatus without the agate cap weighs 4 grains.

2. *Thermo-electric Rotation.*—Mr. Marsh, of Woolwich, has also constructed a variety of apparatus for the exhibition of rotation by thermo-electricity. By the directions of Mr. Barlow, he endeavoured to make an apparatus according to the former instructions of Professor Cumming, but, failing almost entirely in making it act, he constructed some according to his own suggestion, which succeeded perfectly. Fig. 1, will give an idea of this apparatus; the double line represents silver wire, the single line platina wire. They are soldered together and made into a rectangle, having a ring in the lower part for the introduction of the support. A fine point is attached to the upper part of the rectangle, and resting on an agate cap on the top of the support, allows of free motion. When the pole of a magnet was placed as in the figure, and a lamp applied at D, the instrument immediately moved round until the side E came to the flame, and then it moved back again, at last resting at right angles to the lamp and magnet. When a second magnet was placed in a similar position at D, and then the lamp applied either at D or E, rotation began, which was either in one direction or the other, according as the lamp was applied to one end or the other, and soon amounted to thirty revolutions in a minute.



Compound rectangles were then made, having four branches, and performed extremely well: the length of the rectangle is about two inches, the depth an inch, the diameter of the platinum wire $\frac{1}{80}$ of an inch, and that of the silver $\frac{1}{40}$. When two rectangles were arranged on the poles of a horse-shoe magnet, as in Fig. 2, and the lamp applied between them, they continue to revolve as long as the lamp remains burning.

Mr. Barlow has made many experiments with these apparatus, and finds them to accord perfectly with the laws he has laid down in his *Essay on Magnetic Attractions.* Some singular appearances of motion are produced with the compound rectangle, when the magnetic pole being considered as stationary, the lamp is applied beneath the four branches in succession, but they are all reducible to

one simple effect, and subject to one general law.—*Phil. Mag.* lxii. 321.

3. *Thermo-electric Phenomenon with Iron.*—Professor Cumming has remarked, that if in the compound piece of two wires used to produce electro-magnetic effects by heating, one of the pieces be iron, and they be heated by a spirit lamp, the deviation, in some cases, gradually attains a maximum, then returns through zero, and at a red heat assumes an opposite direction; resembling in this respect the deviations before observed with an alloy of antimony and bismuth. These effects took place when iron was connected with silver, copper, gold, zinc, and brass, but not with platina or lead, and has not been observed in other cases where neither of the wires were iron.

The table which we copied in our last Number of the relations of the thermo-electric bodies should be corrected, by having galena put above bismuth, and silver between zinc and ore of iridium and osmium.—*Ann. Phil., N. S.* vi. 321.

4. *Dobereiner's Eudiometer.*—Professor Dobereiner has suggested the use of finely divided platina for the purpose of detecting minute portions of oxygen in a gaseous mixture, in which hydrogen also is present. Its effect is immediate; the moment the substance rises above the surface of the mercury in the tube containing the mixture, the combination of the oxygen and hydrogen begins, and in a few minutes is completed; and, as Professor D. has stated, it seems capable of detecting the smallest quantity of oxygen. Its utility in the analysis of atmospheric air, and compounds containing oxygen, is obvious, provided no combination also takes place between the hydrogen in excess, and the nitrogen (or other gas) that may be present, as does in fact happen, according to Dobereiner, when protoxide of platinum is so employed.

Messrs. Daniell and Children mixed 20 measures of atmospheric air, with 37 measures of hydrogen gas, and passed up to the mixture a small portion of the platina powder, procured by heating the ammonia muriate to redness, and made into a ball with precipitated alumina. The pellet was heated red by the blowpipe, immediately before it was used, its size about that of a small pea. The absorption amounted to 13 measures = 4.3 oxygen, being 0.1 of a measure more than the quantity of oxygen in 20 measures of atmospheric air, which may probably have arisen from a slight impurity in the hydrogen, or from some minute unperceived bubbles of air, entangled in the mercury.

Another mixture of common air and hydrogen, in which the latter was in considerable excess, was deprived of its oxygen by the pellets, and when the absorption was complete, 38 measures of the residual gas were taken, and a fresh pellet, heated to redness, immediately before it was used, passed up. After standing about a quarter of an hour, no absorption had taken place. The tube and the mercury

were then placed before the fire, till the whole apparatus was too hot to be touched with the naked hand. It was then removed from the fire, and when cooled to its original temperature, the mixture occupied, as before, exactly 38 measures. The powder of platina with hydrogen seems, therefore, to be admirably calculated for eudiometrical purposes. Its application is extremely simple and easy, it is speedy in its effect, and no error need be apprehended from the formation of ammonia, even at considerably elevated temperatures. It appears also to be well calculated for ascertaining the purity of simple gases, at least as far as regards admixture of atmospheric air. The oxygen of a very minute portion of common air, mixed with carbonic acid gas, and a little hydrogen, was immediately absorbed, on passing up one of the little pellets to the mixture.

5. *On the Action of Platina on Mixtures of Oxygen, Hydrogen, and other Gases.*—We noticed in our last Number, p. 179, the singular experiments made by M. Dobereiner, on the ignition of platinum by a jet of hydrogen. Several papers have appeared since then, on the same subject, of the matter of which we purpose giving a very condensed account, in the following lines.

The preparation of platinum observed by Mr. E. Davy, which ignites in contact with the vapour of alcohol, is well known. M. Dobereiner*, by precipitating a solution of platina by sulphuretted hydrogen, and exposing the dry precipitate to the air for a few weeks, obtained an oxidized sulphuret, having similar properties, and further ascertained that both these substances enabled the alcohol to attract oxygen gas, producing acetic acid and water at the same time with the phenomena of ignition before referred to. By further experiments, it was ascertained that neither oxygen nor carbonic acid gas was absorbed by these two substances, but that every inflammable gas was; and 100 grains of the protoxide of platinum (Mr. Davy's substance,) absorbed from 15 to 20 *c. i.* of hydrogen gas with ignition of the substance, and also of the hydrogen, if previously mixed with air or oxygen. The preparation of platinum charged with hydrogen readily attracts as much oxygen as will combine with the hydrogen it contains, so that air being admitted, the oxygen instantly disappears; and even ammonia is formed, if there be not enough oxygen for the hydrogen in the platina. The platina immediately reduced, loses some of the properties it before possessed, but retains the power of determining the combination of hydrogen gas with oxygen gas, and with the evolution of so much heat, as, if the experiment be made properly, to ignite the platinum. M. Dobereiner immediately concluded that the platina obtained by heating the ammonia-muriate would have the same effect, and found his expectations confirmed by experiment. This experiment was made July 27, 1823.

M. Dobereiner considers the phenomenon as an electric one, and that

* *Annales de Chimie*, xxiv. 91.

the hydrogen and platina form a voltaic combination, in which the former represents the zinc. Another remarkable result was obtained with the oxidized sulphuret of platina. Placed in contact with carbonic oxide, the gas diminished to one half, and became carbonic acid; hence it is decarbonized by the solid substance. In a supplement to the paper just abstracted, in which M. Dobereiner describes the mode of making the experiment, as we have stated, by a jet of hydrogen, he mentions also, that he had applied it to the construction of a new apparatus for procuring fire.

In a further communication to the public *, on this subject, M. Dobereiner says, that the energy of hydrogen is so much increased by the presence of platina in powder, that it will in a few minutes completely separate one part of oxygen, from 99 of nitrogen, an effect which the strongest electrical spark will not produce. In these experiments, platina in powder is mixed with potters'clay, moistened, and made into small balls, about as large as a pea, these are dried and then heated to redness, one of these balls, weighing from 2 to 6 grains, will convert any quantity of detonating gas into water, and may be employed above a thousand times, if dried carefully after each operation.—The compound gases, containing hydrogen, do not combine with oxygen, when in contact with platina. A jet of hydrogen on the platina, precipitated by zinc from a solution, made it red hot, with a crackling noise and sparks; this powder is a mixture of platina and its oxide, and converts alcohol, when oxygen is present, into acetic acid. Nickel prepared from the oxalate, has the property of converting oxygen and hydrogen gases slowly into water.

MM. Dulong and Thenard †, have verified the experiment, of the ignition of platina by a jet of hydrogen, and have added some other facts on the same subject. They remarked, as M. Dobereiner had done, that introduced into a mixture of oxygen and hydrogen, it determined the combination of the gases sometimes with ignition; that the platina, strongly calcined, loses the property of becoming incandescent, but still slowly causes condensation; that finely-divided platina, obtained by other means, or wires, or laminæ, had no action at common temperatures, but that very thin leaf platina crumpled up together acted instantly, although the same leaf rolled round a cylinder of glass, or suspended freely in the gases, had no action; but the leaves, wires, powder and plates, all acted slowly at temperatures between 400° and 572° F. Palladium in thin pieces acted at an elevated temperature, as well as platinum of the same thickness. Rhodium caused the formation of water at about 464° F. Gold and silver, in leaf, acted at a temperature somewhat under that of boiling mercury.

* *Annales de Chimie,* xxiv. 91. *Bib. Univ.* xxiv. 54.
† *Annales de Chimie,* xxiii. 440.

Carbonic oxide and oxygen form carbonic acid; nitrous gas is decomposed by hydrogen at the common temperature, by contact with spongy platinum; and a mixture of olefiant gas, with sufficient oxygen is changed into water and carbonic acid at 572° F.

These philosophers then observe that certain metals have the property of decomposing ammonia, without absorbing either of its elements, at a temperature at which the ammonia by itself would be quite unchanged; 150 grains of iron wire are thus sufficient for decomposing nearly the whole of a rapid current of ammoniacal gas, continued for 8 or 10 hours, whilst thrice as much platina wire does not produce a like effect, even at a much higher temperature. These results depend, perhaps, on the same causes which make gold and silver effectual in combining oxygen and hydrogen, at 572° F., massive platinium at 518° F., and spongy platinum at common temperatures. Now as iron so well separates the elements of ammonia, and scarcely at all effects the combination of hydrogen with oxygen, whilst with platinum it is the reverse; the authors are induced to suppose that some gases tend to combine under the influence of metals, and others to separate, the effect varying with the nature of each; but they refrain from offering conjectures until supported by experiments.

MM. Dulong and Thenard, have also ascertained that spongy palladium will inflame hydrogen as platina does; that iridium in the same form became hot and produced water; that cobalt and nickel in masses, cause the gases to combine at about 300° F.; that cold spongy platina formed water and ammonia, with nitrous gas and hydrogen; and acted also on mixed hydrogen and nitrous oxide gases.

Mr. W. Herapath * has made experiments on this subject, most of which being of a similar nature to some of those already described, we omit to specify. His attention was particularly directed to the temperature at which the effect first began to take place, and he states as the results of his experiments on this point, that if the gases have a temperature of 55°, the platina requires a temperature so high as 98° to cause them to unite.

Mr. Garden of Oxford Street, has also experimented on this subject †, and has found, that the black powder, consisting of iridium and osmium, left when crude platina is digested in nitro-muriatic acid, if heated red hot and then suffered to cool, acts as well as spongy platina itself. He also ascertained that a jet of hydrogen cooled to 32°; if thrown upon spongy platina cooled also to 32°, quickly heated it to whiteness, and became inflamed, a result which contradicts Mr. Herapath's statement, and shews that the limit of temperature at which spongy platina ceases to act on mixed oxygen and hydrogen gas has not yet been attained.

* *Philosophical Mag.* lxii. 286. † *Annals Phil. N. S.*, vi. 468.

6. *Solar Light and Heat.*—Mr. Powel has been engaged for some time in experiments on solar light and heat. He has examined the heating power of the prismatic rays, but chiefly with respect to the effects, said to be produced, beyond the red end of the spectrum. He has found that such effects are really produced, but has accounted for their being observed in some cases and not in others, from certain differences in the coatings of the thermometers employed. He has concluded from a number of experiments with different coatings that this heating effect is similar in its relation to surfaces to common radiant heat, and differs essentially in this respect from the heating power *within* the spectrum. He has made other experiments from which the nature and origin of this effect, may, with great probability, be inferred. The details will soon be made public.—*Ann. Phil. N. S.*

7. *Benzoic Acid in the ripe Fruit of the Clove Tree.*—The clove is the flower bud of the *Eugenia Caryophillata*, and the ripe fruit used formerly to be used in medicine under the name of *Antophylli.* In the latter, Mr. W. Bollaert has observed crystals of benzoic acid lining the cavity between the shell and kernel.

8. *Certainty of Chemical Analysis.*—We mentioned at page 164, the conclusions to which M. Longchamps had arrived, as the results of his experiments on the uncertainty of the means of chemical analysis, at present in the possession of chemists. His experiments convinced him that no certainty could be obtained. Mr. Phillips, who has also examined this question, considers the inferences of M. Longchamps as unsupported even by his own Mémoire, and from his own experiments is satisfied of their inaccuracy. Some sulphuric acid was diluted and divided into eight parts, four of these were precipitated by nitrate of baryta, and four by the muriate of baryta; the precipitates were carefully washed and dried, and then weighed, those from the nitrate were 128.7; 128.0; 128.3; 128.6 grains, mean 128.4: those from the muriate, 128.1; 128.7; 128.0; 128.5; mean 128.325. These results are certainly very different to M. Longchamp's.—*Ann. Phil., N.S.*, vi., 289.

9. *Correction of bulk of Gases for Temperature.*—Some of our elementary treatises on chemistry contain an inaccurate mode of estimating the change of bulk in a gas, occasioned by variation of temperature. They have directed that the bulk of the gas be divided by 480, the quotient multiplied by the number of degrees by which the temperature of the gas differs from the temperature to which it is to be reduced, and the product added, or subtracted, according as the actual temperature is below or above that referred to. But as the expansion of a gas, for each degree of Fahrenheit is $\frac{1}{480}$ of its bulk at 32° only, and at no other temperature the above rule is not

correct, except for cases where gas at 32° is to be estimated at some other temperature. Mr. Biggs has pointed out this error in the *Annals of Philosophy*, vi. 415, and has given the following more correct rule. Add the degrees which the gas is above 32° to 480, add also the degrees which the required temperature is above 32° to 480, then as the first number is to the second, so is the volume of the gas to the volume required. Another rule for making the correction is, to add the number of degrees between 32° and the temperature of the gas to 480, divide the volume of the gas by the sum, and multiply the quotient (which will be the expansion for each degree) by the number of degrees between the temperature of the gas, and the required temperature; if the latter be greater than the former, add the product to the volume of gas, if it be less subtract it, and the corrected volume will be given.

10. *Supports for Ignition of Particles by the Blow-pipe.*—The sappare is a substance recommended by M. de Saussure, for the support of minute particles intended to be subjected to the action of the blow-pipe, but is seldom used in consequence of the difficulty of making the particle adhere to it. In place of the water, saliva, or gum-water, generally used, Mr. Smithson recommends the use of a mixture of water and refractory clay; a little of the moist clay is to be taken up on the end of the splinter of sappare, and the particle to be heated being touched by it adheres, the whole is laid aside for a few minutes, and is then dry and may be heated. Mr. Smithson also recommends small triangles, or slender slips of baked clay in lieu of sappare, which is not always to be had. Another more recent process is, to file the very end of a platina wire flat, place the minutest portion of the moist clay on it, and then touch the particle to be heated. In a few moments it is dry, and may be put into the flame without flying off, unless too much clay has been taken.

Mr. Smithson points out a remarkable difference between quartz and flint before the blow-pipe. Quartz is almost refractory, but flint fuses with facility, swells, and even froths. It is aked whether flint does not, like pitch-stone, contain bitumen, which at a certain heat tends to tumefy it?—*Ann. Phil.* N. S. vi. 412.

11. *Solubility of Substances induced by Tartaric Acid.*—The following observations on solubility conferred by tartaric acid, are given in a note by M. Rose, in a Memoir on Titanium. "It is known that a solution of peroxide of iron containing tartaric acid, cannot be precipitated by caustic alkalies, by their carbonates, or succinates; its presence is indicated only by tincture of galls, ferro-prussiate of iron and hydro-sulphurets. I thought, therefore, I should obtain an oxide of titanium perfectly pure, by mixing tartaric acid with a solution containing the oxides of iron and titanium, and then adding ammonia to precipitate the oxide of titanium. But I found that many solutions

of oxides containing tartaric acid could not be precipitated by alkalies or their carbonates, though they fell immediately if that acid were away. Among these is the oxide of titanium, which is not then precipitated by the alkalies or carbonates; also alumine, of which the presence cannot be discovered in a solution containing tartaric acid; oxide of manganese, oxide of cerium, yttria, oxide of cobalt, oxide of nickel, magnesia, protoxide of iron, oxide of lead, when the solution contains nitric acid to keep the tartrate from precipitating, oxide of copper, and finally oxide of antimony, of which the solutions containing tartaric acid are not precepitated, either by alkalies or any abundance of water. I have employed this property of oxide of antimony with much success, in the analysis of the salts and ores of that metal. Though oxide of bismuth does not possess this property, it does not afford a means of separating it exactly from oxide of antimony. There is scarcely any acid but the tartaric which possesses this remarkable property of forming salts with many oxides, which cannot be precipitated by the alkalies. The phosphoric and arsenic acids are the only ones which in this respect, present any analogy.—*Ann. de Chim.* xxiii. 356.

12. *On two New Coloured Test Papers.*—The following account of these test papers is abridged from the description given of them by M. C. Pagot des Charmes, who has used them for many years with advantage in testing for acids and alkalies.

The first is obtained from the violet pellicle, which covers the root of the small radish, (raphanus sativus oblongus,) the second from the skin of the common red radish (raphanus vulgaris.) The directions with respect to the small radish, are to scrape off the coloured skin with a knife, and as it soon changes in the air, to collect them rapidly, put them in a piece of clean linen, and compress them, when a clear transparent blue fluid will be obtained. This test fluid may be preserved as it is out of the contact of air, or made into a syrup, or laid on paper by a brush; and the paper thus prepared, preserves its fine sky-blue colour in contact with the air for any length of time. This test is extremely sensible to acids and alkalies.

The scrapings of the common radish require to be bruised in a mortar before pressure; they do not yield so much juice, but the tint is very fine either in the fluid state, or on paper, and the test it affords is a very delicate one. These preparations are recommended above litmus, by their being equally sensible, and yet unaltered in the air, and by being readily obtained every where.—*Jour. des Phys.* xcvi. 136.

13. *On the Presence of Ammonia in Rust of Iron, formed in habited Houses.*—M. Vauquelin was called upon to examine some red spots found on a sabre, which was supposed to have been used in the commission of a murder, the spots being produced by blood; a small

portion of the red matter was introduced into a glass tube, closed at one end and heated, the other being occupied by a strip of litimus paper, reddened by an acid; a yellow vapour rose, from the substance which changed the red colour of the paper to blue.

A second experiment was made with the matter of some red spots found on a knife which was supposed to have been put to the same use as the sabre, being found in the house where a murder had been committed, and exactly the same results were obtained.

These facts tended to strengthen the suspicions previously raised; but although a medical man did not hesitate to assert that the spots were actually blood, yet they resembled rust much more than blood. The experiment was therefore repeated with common rust from a piece of iron found by accident in the judge's cabinet; this rust gave exactly the same result as the former, and the suspicions before existing were of course destroyed.

The fact proves that rust formed within houses is capable of absorbing and strongly retaining the ammoniacal vapours there developed. It also absorbs animal vapours, for in all these experiments vestiges of a brown oil were constantly observed on the surface of the tube.

M. Laugier has confirmed this result with rust found in his laboratory, and has further observed the development ultimately of sulphuric acid in the experiment.— *Ann. de Chim.* xxiv. 99.

14. *New Carburetted Hydrogen Gas.*—M. Clement states as information which he had received directly from Mr. Dalton, that the latter chemist had found a new carburetted hydrogen gas in oil gas. This new gas contains twice as much carbon as olefiant gas, and has been named by Mr. Dalton super-olefiant gas. There is a great quantity of it in oil gas.

In reference to this subject we may refer our readers to a paper in the *Annals of Philosophy*, *N.S.* iii. 37, where a gas of the same chemical composition as olefiant gas, but of twice its density, is, from the experiments of Dr. Henry, inferred as existing in oil gas.

15. *On Titanium, by* M. Rose.—Oxide of titanium was obtained pure by fusing powdered rutilite with thrice its weight of carbonate of potash, dissolving the compound in muriatic acid, precipitating by caustic ammonia, digesting the precipitate for a certain time with hydro-sulphuret of ammonia, and then digesting the solid matter left in weak muriatic acid, which leaves the oxide of titanum pure. In this way only as yet can the iron be removed. The pure oxide remains perfectly white when heated and cooled, and is then untouched by acids; fused with carbonate of potash, and then treated with muriatic acid, it sometimes gelatinizes, though not so strongly as silica. It becomes red by touching moistened litmus, and with alkalies

acts precisely as an acid. It has therefore been called by M. Rose, titanic acid.

Titanates. When fused with carbonate of potash in excess, two substances are obtained in the crucible; the upper is the excess of carbonate, the lower the neutral titanate of potash. In neutral titanate thus prepared, the oxygen of the acid is to that of the base as 2 to 1, and as titanic acid was found by calculation from experiments on the sulphuret of titanum, to contain 33.95 per cent. of oxygen, its capacity of saturation was considered consequently as being 16.98.

These neutral titanates are decomposed by water, which removes part of the potash, and leaves insoluble acid titanates. The acid titanate of soda contained titanic acid 83.15

Soda . .	16.85
	100.

acted on by muriatic acid, a further portion of soda was removed leaving a salt composed of titanic acid 96.38

Soda . .	3.62
	100.

The acid titanate of potash gave titanic acid 82.33

Potash . .	17.77
	100.

There are no salts with base of titanic acid; those compounds which have been taken for such, resulted from the presence of alkali in the titanic acid; but when the acid titanate of potash is dissolved in muriatic acid and diluted, precipitates may be obtained by adding the sulphuric, arsenic, phosphoric, oxalic, and tartaric acids, which are binary compounds of these acids with titanic acid. The compound with sulphuric acid when heated, yields pure titanic acid; when moderately dried, it strongly attracts moisture from the atmosphere. It contains

Titanic acid . .	76.67
Sulphuric acid .	7.67
Water	15.66
	100.00.

The compound with oxalic acid contains

Titanic acid . .	74.10
Oxalic acid . .	10.40
Water	15.50
	100.00

Sulphuret of Titanum.—M. Rose did not succeed in reducing titanium: but by passing the vapour of sulphuret of carbon over it at a very intense heat, succeeded after many trials in forming an uniform and perfect sulphuret. It was of a deep green colour, and on the

slightest touch with a hard body, exhibited a strong metallic lustre, similar to that of yellow copper. Heated with access of air it burnt, producing sulphurous acid and leaving titanic acid. Nitric acid converted it into titanic acid, liberating sulphur. When analyzed by combustion it gave as its elements

Titanum	49.17
Sulphur	50.83
	10.000

and for the elements of titanic acid

Titanum	66.05
Oxygen	33.95
	100.00.

As a test that the degree of oxidation in titanic acid corresponds with that of the sulphuration in the sulphuret, a portion of the latter was boiled in solution of caustic potash; the sulphuret was soon decomposed, and titanate of potash was deposited; and the liquor being acted on by muriatic acid, gave sulphuretted hydrogen without any deposition of sulphur.—*Ann. de Chim.* xxiii. 353.

16. *Cadmium from Zinc Works.*—Mr. Herapath formerly stated the presence of cadmium in the zinc works of Bristol, (see vol. xiii. p. 427.) He finds that if the powder there referred to be introduced into an iron bottle and tube similar to that used for obtaining oxygen from manganese, a piece of paper pushed down upon it, and the apparatus placed above the neck in any furnace or fire-place, where a bright red heat can be produced; the cadmium will be found in the cold part of the tube, or resting on the charred paper, if a larger quantity has sublimed than can support itself. It now exists in small globules, and may be obtained in a button, in the way formerly described. It is requisite that paper or some substance be introduced to remove the oxygen of the atmosphere in the bottle. After this process the powder still contains cadmium, which may be separated by solution in muriatic acid, and precipitation by zinc; iron and cadmium precipitate and the mixture distilled as before furnishes more cadmium.

The sulphuret is proposed as a pigment nearly equalling in beauty the chromate of lead.—*Phil. Mag.* lxii. 167.

17. *Alloy of Zinc and Iron*—This alloy was collected by M. Herapath in a zinc manufactory at Bristol. It lined the tube leading from the retort. It was hard and brittle, the fracture shewing broad facets like zinc, but of a duller grey colour, with surfaces more rough and granular. Its specific gravity 7.172. It was composed of 92.6 zinc, and 7.4 iron per cent.—*Phil. Mag.* lxii. 168.

18. *Muriates of Baryta, Strontia, and Lime.*—Mr. Phillips has examined the various statements given of the composition of the salt sometimes called chloride of barium, and sometimes muriate of baryta. Although the relative proportions of chlorine and barium existing in it as a chloride, and of muriatic acid and baryta afforded by it when considered as a muriate, have been ascertained with considerable precision, yet the accurate proportions of the crystallized salt have not been stated. Mr. Phillips, on a careful comparison of the various analysis that have been made, states its composition to be as a chloride,

1 atom chloride barium	106		Chlorine	29.03
2 —— water	18	or	Barium	56.45
	——		Water	14.52
	124			——
				100.00

or as a muriate,

1 atom mur. barytes .	115		Muriatic acid .	29.84
1 —— water	9	or	Barytes	62.90
	——		Water	7.26
	124			——
				100.00

The equivalent numbers of crystallized muriate of strontia are

1 atom chloride stront. $36 + 44 = 80$
6 —— water 9×6 . . . . . . $= 54$
——
134

or 1 atom mur. strontia . . . . . . $37 + 52 = 89$
5 —— water . . . . $9 \times 5 = 45$
——
134

The equivalent numbers of crystallized muriate of lime are

1 atom chloride of calcium . . $36 + 20 = 56$
6 —— water . . . . $9 \times 6 = 54$
——
100

or 1 atom mur. lime . . $37 + 28 = 65$
5 —— water . . . . $9 \times 5 = 45$
——
110—*Ann. Phil. N.S.* vi. 339.

19. *On a Quadruple Salt.*—Whilst separating cadmium from the metals which always accompany it, M. Tassaert had occasion to observe the formation of a singular salt. The ore of zinc had been dissolved in sulphuric acid and ammonia added, but not to neutralization; a plate of zinc was then added, which, after some time, was found covered with colourless transparent crystals. These, separated and examined, were found to contain ammonia, sulphuric acid, oxide

of iron, oxide of zinc, and water: when analyzed, the following proportions were obtained:—

Water of crystallization	30.90
Sulphate of iron	3.16
Sulphate of zinc	39.00
Sulphate of ammonia	26.94
	100.00

The water of crystallization surpasses the quantity which would be required by the sulphates separately, and this fact is adduced by M. Tassaert, as an argument in favour of the whole being the result of chemical combination, and not a mere mixture.—*Ann. de Chim.* xxiv. 100.

20. *Pyrophorus from Tartrate of Lead.*—Dr. Gobel, whilst working with the tartrate of lead, remarked that when heated in a glass tube, a very perfect and beautiful pyrophorus was produced. When some of the dark-brown mass thus formed was shaken out into the air it immediately inflamed, and brilliant globules of lead covered the ignited surface; some of these changing, by degrees into litharge, offered a very beautiful appearance. The ignition continues much longer than with other pyrophori, which circumstance, with the facility of preparation, may make it a convenient means of obtaining fire.

The inflammation of these substances, as Dr. Gobel remarks, has been attributed principally to the presence of potassium, but this substance affords a new proof that other metallic compounds are susceptible of spontaneous inflammation on the accession of air.

21. *On a Green Pigment.*—The preparation of a beautiful green colour is described in our last volume, at p. 309; but an easier process for the production of the same colour having been given by Dr. Liebig, we insert it beneath. A given weight of verdigris is to be dissolved by heat in a copper vessel in a sufficient quantity of pure vinegar, and then an aqueous solution of an equal quantity of white arsenic added; generally a dull green precipitate falls, which must be redissolved by adding more vinegar. The mixture is then to be boiled, and after some time a crystalline precipitate appears, of the finest green colour, which, separated, washed, and dried, is the substance in question. If the liquor still contains copper, arsenic is again to be added; or if it contains an excess of arsenic, the preparation of copper must be added, and the process carried on as before. Sometimes the liquor contains an excess of acetic acid, and may then be employed to dissolve verdigris, as at first.

Thus prepared, the colour has a bluish tint, but it may be obtained of a deeper and more yellow tint, yet with the same brilliancy and beauty; for this purpose a pound of common pearlash is

to be dissolved in a convenient quantity of water, ten pounds of the colour obtained as above added to it, and the whole heated over a moderate fire; the colour will soon change and take the tint required. If boiled too long, the colour approaches that of Scheele's green, but always surpasses it. The alkaline liquor remaining may be used in the preparation of Scheele's green.—*Ann. de Chim.* xxiii. 412.

22. *Peculiar Effects of burning on Limestone or Chalk.*—M. Vicat, of whose excellent work on Cements and Mortars we gave a short account, vol. x. p. 407, has lately obtained some singular results in the burning of lime. Many years since he observed, whilst burning pure lime with charcoal and coal in a small furnace, that if the fragments of lime on passing through the furnace into the ash-pit, were again put in with fresh fuel, and this many times successively, a lime was obtained incapable of slaking, but which, broken up and made into a paste, had the remarkable character of setting under water.

It is an old opinion among lime-burners that limestone which has cooled before it has been completely burnt, cannot by any quantity of fuel be converted into quick lime, and M. Vicat considers this opinion as supported by the experiment above. It appears to result, M. Vicat says, that pure calcareous matter, as chalk or marble for instance, may be brought by fire into an intermediate state, being neither lime nor a carbonate, and that in this state it has the property, when pulverised and made into a paste, of setting under water.

Chalk converted into lime, and slaked in the usual way, yields a hydrate, which, made into a paste, will not harden in water; but the same lime left to fall into powder by long exposure to the air, and then made into a stiff paste with water, will solidify very sensibly after immersion. The action of the air here occasions the formation of a compound analogous to that afforded by imperfectly burnt chalk, being like that, neither completely lime or completely carbonate; and it enjoys the same hydraulic properties.

Ten equal portions of finely-powdered chalk were taken, and a plate of cast iron being heated red hot, they were placed upon it; one portion was allowed to remain three minutes, another six, a third nine, and so on, and during the time they remained on the plate they were continually stirred, that all parts might be equally calcined. These portions were mixed up, with a small quantity of water, into pastes of equal consistency, no signs of slaking were observed; the first portions gave the ordinary odour of moistened chalk, the latter portions gave the alkaline odour belonging to lime, and were decidedly alkaline. After twenty-four hours of immersion in water all the numbers, except the first had set, as hydraulic lime would have done, and became harder daily, whilst the first remained soft. When, after some time, the comparative hardness of the second and the tenth were tried, no apparent difference could be perceived.

Viewing these substances as mixtures, in various proportions of lime and carbonate of lime, M. Vicat thought it probable they might be imitated, but no mixture made by adding lime and carbonate of lime, to each other, gave the least signs of solidification under water.

Very analogous results to these were obtained by M. Raucourt de Charleville; but the most remarkable effect was observed when the fuel used was charcoal. He had prepared a mixture of pure lime and clay, which, when dry was broken into small pieces, and burnt, either on a heated plate or in a furnace, all the results furnished hydraulic lime, except those which had been burnt in contact with charcoal. Hence, observes M. Vicat, the contact of the charcoal had deranged the action which occurs between lime and clay in the ordinary mode of burning, and presents a phenomenon very difficult to explain. At first, it might be supposed that the iron required per-oxidation, before it would combine with the lime, and that the charcoal prevented this; but the experiments of M. Berthier prove that the iron is nearly passive in these and similar cases.—*Ann. de Chim.* xxiii. 424.

In addition to these experiments, it may be remarked, that M. Clement, whilst stating the occurrence of a substance in France fit for the fabrication of Roman cement, and which was discovered by M. Minard, gives an opinion formed by M. Minard, from many experiments, "that Roman cement owes its quality to a sub-carbonate of lime, produced by the action of fire on the natural carbonate."—*Ann. de Chim.* xxiv. 106.

23. *New vegetable principle, Dalhine.*—M. Payen has discovered a new substance in the bulbs of the Dalhia, which has been called *dalhine* and besides it, an uncrystallizable sugar, aroma, a volatile, and a fixed oil, albumen, silica, and several calcareous salts.

To extract the *dalhine*, the pulp of the bulbs is to be diffused in its weight of water, filtered through cloth, the liquid mixed with one twentieth its weight of common chalk, boiled for half an hour, and filtered. The residuum of the bulbs is then to be pressed, the solutions united and evaporated to three fourths of their volume; 4 per cent of animal charcoal must then be added, and the whole clarified by the white of an egg. The liquor filtered and evaporated, until a film forms on the surface, deposits dalhine on cooling. All the washings are to be treated in the same way and thus 4 per cent of dalhine, will be obtained from the bulbs.

This substance when pure, is white, inodorous, pulverulent, tasteless, of a specific gravity 1.356, more soluble in hot, than in cold water, not soluble in alcohol, but precipitated by it from aqueous solutions. Potash dissolves it, ammonia does not, sulphuric acid converts it into an uncrystallizable sugar more sweet than that of starch.

This substance has some analogy with starch, inuline, gelatine, &c., but differs from them in forming a granulated mass when its aqueous solution is evaporated, by its specific gravity, and other qualities.—*Ann. de Chimie*, xxiv. 209.

III. Natural History.

1. *Amici's Microscopical Observations.*—Professor Amici, of Modena, has published the results of his microscopical observations on various plants, in the *Proceedings of the Italian Society of Sciences at Modena.* We have only seen an account of these researches in the *Bibliothèque Universelle*, xxiii., and have made the following abstracts from it. The work of Amici is illustrated by several large plates, of the accuracy of which, and also of the descriptions, his abilities and means are securities.

Circulation of the Sap in Vegetables. Caulinea fragilis.—Corti first discovered the motion of the sap in plants, and among others in an aquatic plant of which he has not given the name, but only an imperfect figure; it proved to be that of which Wildenow made a genera under the name of *Caulinea.* Some time since Amici observed and described a similar phenomenon, in the *chara vulgaris:* the circulation was seen in the vessels of this plant, always in the same direction, and was supposed to be caused by small crowns of green particles lining the internal membrane of the tube.

A transverse section of the *Caulinea*, viewed by powers of 60 and 150, appeared as a polygon of 8 rays, each formed by a range of circular bodies; the centre was occupied by a large tube, surrounded by a bundle of smaller tubes parallel to each other, and in which were diaphragms at a considerable distance one from another. These vessels contained only air, which escaped in bubbles, when they were cut under water; all the other apertures in the section, are those of the vessels which conduct the sap, and which also have diaphragms, more or less distant from each other. No proper trachæ or porous tube was discovered.

Each cavity of the *Caulinea* formed a particular vessel, in which the liquid moved, independent of the circulation in the neighbouring vessel, and in a manner analogous to the movements before observed in the vessels of the *Chara.* The fluid contains visible concretions which moving with it indicate its course, and the velocity of its motion in different parts. These particles are globular, of the same size in the same vessel, but varying in different parts of the plant. The motion is as follows:—globules ascend on the one side of the tube containing them and the liquid until they reach a diaphragm, when they move horizontally to the opposite side, and descend, until coming to a diaphragm beneath, they move horizontally in the

opposite direction to the first horizontal motion, and again ascend as before. This effect continues as long as the plant is alive. All the globules are not in contact with the surface of the tube; those which are at some little distance, circulate as well as the others, but less rapidly; and their motions were slower, as they were nearer to a plane, which may be supposed to pass through the tube, and separate the two currents. Sometimes the globules displaced each other, at other times they passed from the one side to the other, before they reached the diaphragm. The directions of the motion in two parallel and contiguous vessels appeared to have no relation to each other. The rapidity is variable, according to the size and length of the canal, and the degree of injury it may have suffered in preparing it, a complete circulation has been observed in a vessel $\frac{1}{3}$ of a line, in length, in 30″, this velocity is not more than a third of that observed in the *chara vulgaris*. It is to be remarked that when the plant is cut, to submit it to observation, the circulation is suspended for a time and requires some hours to be renewed.

The circulation of the sap takes place in the cellular tissue as well as in the vessels, the globules move along the surface of the cell, changing their direction when they arrive at the angles of the polygons. Sometimes a mass of globules collect in the centre and rotate with a motion common to the whole. Observations on the leaves are more delicate, than those on the stalks of the plants, they require to be made whilst the leaf is attached to the plant, and the light must be thrown from above, as for opaque objects.

Thus each vessel presents two currents, one ascending, the other descending, which are not separated by any division: the interior is studded with small crowns, composed of particles which are very difficult to discover, because of their tenuity and transparency, and the nature of the motion shews it to arise from the surface of the tube, and precisely from those points occupied by the crowns, for there may be observed the maximum of the velocity with which the globules move.

M. Amici does not state that no liquid passes from one cavity to another, he is indeed convinced of the contrary; but the transfusion takes place through invisible apertures, through which the globules cannot pass. He has remarked two varieties of limpid fluid in the *Caulinea*, one white and one red, contained in different vessels, though of the same form. He attributes the distinct green colour of the plant, to globules very green themselves, floating in the fluid; they are greener towards the exterior of the plant, than in the interior. There is this difference between the *Chara* and the *Caulinea*, that in the first the globules are white, and the particles of the small crowns green, the latter colour the plant; but in the second, the globules are green, and the crowns yellow. Oil and alcohol do not alter the form of the globules of the *Caulinea* but discolour them entirely.

Chara flexilis. The organization of this plant is exceedingly simple, a section of the root, the trunk, the branches, or the leaves, pre-

sents but a single circular aperture belonging to a tube transparent as glass, and furnished in the interior with small crowns of green particles as in the *Chara vulgaris*. This tube contains a colourless liquor and white globules of various dimensions, some of them far surpassing, in size, the green globules adhering to the surface. These appearances are easily perceived, without any preparation of the plant, and with a common microscope. This plant has flowers, in the organs of which the circulation of the sap may be perceived in all their stages. The regular order preserved in the tubes by the two series of crowns, those of the ascending, and those of the descending, side is very remarkable and evident. The circulations in the vessels are independent of each other, so that if one is injured, the others still preserve their functions.

Of the Pollen. The principal object of M. Amici, under this head, is to describe a phenomenon, which he is anxious should be verified by other naturalists, but he forewarns them that a linear power of 300 is necessary for its observation; the drawing he has himself given was from a specimen magnified 1000 times. The Pollen was from the *Portulaca oleracia*. The figure represents a globe, 2½ inches in diameter, attached laterally to a curved tube, which descends vertically; between the tube and the globe and in contact with both is the superior extremity of a hair of the stigma, which forms also a transparent tube, filled with small corpuscules circulating slowly in it. On first observing it the author remarked nothing particular, but on a sudden the globe opened, and a tubular tail extended from it, which passing above the extremity of the hair of the stigma returned beneath it, thus applying itself to it and doubling its diameter; the membrane forming this tube was very transparent. This tube was filled with globules, which after circulating through it, passed into the globe of pollen, which itself was full of corpuscules in motion, and fresh globules supplied their places from it. The same kind of motion was observed in the vessels of the stigma. This phenomenon continued for three hours, after which time the corpuscules disappeared from the tube. M. Amici could not decide whether they had returned to the globe, or entered the cells of the stigma, or been otherwise disposed of.

It is necessary to an observation of this kind, that the flower be gathered a short time before it fades, the interior pistil separated and placed under the microscope; the most favourable light is that of the sun: if then the globules of pollen already adhering to the extremities of the hairs of the stigma, be placed at the focus of distinct vision, and all humidity excluded, they will appear perfectly spherical, but shortly they will be seen to explode and develop the tube-like tail, and the phenomena will appear as above described. The effect takes place more readily as the weather is warmer. The flower, gathered about eight A.M., preserves for nearly three hours the power of exhibiting this phenomenon.—M. Amici considers the globules

which he saw circulating in the tail, as the same as those which other observers have remarked as a little cloud, when a globe of pollen has been broken.

The pollen of the flower of the *cucurbita pepo*, are globes, which when moistened presented, at different points of their surface, very transparent vesicles, at the summit of which were adapted small opaque covers with a projecting spine in the middle; this cover appears to act as a valve whilst the vesicle is within the globules. If the pollen be dipped in alcohol, before being placed in water they do not break, and the phenomena of the vesicles are better observed.

The pollen of the *cichorium inlybus* is of a regular dodecaëdral form, with pentagonal faces; put on to water it bursts at one of the faces and throws a liquid to a distance twice its own diameter, some of the other faces swell and produce vesicles, analogous to those before mentioned, but without the operculum.

On the Epidermis. The epidermis of the leaves of a great number of plants examined by M. Amici, is a tissue formed of a layer of cells, independent of those of the parenchyma which are covered by it. It is white, transparent, and may be removed without laceration of the subjacent parenchymatous layers, of which each has its particular membrane, which adheres only by contact to the epidermis.

M. Amici refutes the opinion of those who affirm the common nature of these two substances, by pointing out that in many cases (*dianthus caryophyllus* for one,) the cells of the epidermis are quadrilateral, whilst those of the parenchyma are cylindrical tubes, of various lengths, perpendicular to the plan of the epidermis. But these vary in different plants, and are sometimes very singular. The difference in the figures of these cells may readily be seen without removing the epidermis, by only changing the focus of the microscope by a quantity equal to the thickness of the epidermis; they are thus presented alternately to the eye, and their want of correspondence made evident. The spaces which the varied dispositions of the parenchyma produces are filled with air; and they correspond with areas of an oval form in the epidermis, in the centre of which may be observed apertures, sometimes open and sometimes closed. In leaves of the *ranunculus repens* and *ruta graveolens*, the organ terminated by these orifices is a small bag or purse, which is opened or closed by a sphincter according to circumstances, not merely spontaneously in the living plant, but at the will of the observer. They are generally open in sun light, closed in darkness; large when the leaf is dry, narrow when it is moistened. In the *ruta graveolens*, when the pores are open, the parenchyma composed of small green tubes may be seen, when closed the green disappears, and the orifices take an ash colour.

With regard to the functions of these pores, it is concluded, that they are not intended for absorption of water, because they close

when moistened, and open to light and dry air; because roots and plants living under water have them not, floating leaves have them only on their upper surface; and because (with reference to rain and dew) they are more abundant on the under surface of leaves, than on the upper. That they are not intended for evaporation is assumed, because the plant being separated from the root they close, although evaporation still goes on. That they are not excretory organs, appears from their corresponding with cavities containing neither fluid nor solid matter. It is therefore concluded that they are intended for the passage of air, but whether for its entrance or exit is difficult to determine. At night when the large pores of the epidermis are closed, the leaves absorb the carbonic acid dissolved in the dew, whilst by day when they are open, the same leaves decompose the gas; hence, perhaps, they may be destined, M. Amici thinks, to the emission of the oxygen gas resulting from this decomposition; an opinion favoured by the remark of M. De Candolle, that the corolla which has no pores produces no oxygen.

Mode of Union in the vegetable Structure.—It has been a question whether the vessels of plants are all constructed of one continuous and single membrane, or whether each vessel has a complete membrane of its own. M. Amici in examining this point has not only ascertained the latter to be the case, and shewn that the membrane between two vessels is in consequence always double, as well at the diaphragms as at the sides; but has shewn that they frequently are really separated, having curved surfaces and spaces between them: these intervals never contain any thing but air, and they put the existence of the *vasa revehentia* of Hedwig, and the *meatus intercellulares* of Link beyond doubt.

On the Air Vessels of Plants.—M. Amici considers every vessel or vacuity whatever may be its form, tubular or cellular, in which the microscope discovers orifices, or openings more or less long, as air vessels. This class comprehends the spiral vessels, the false trachæ, the porous tubes, the vessels with false partitions, those with small crowns, those with false cells, and a great variety of others. A recent section of a plant shews these vessels empty and dry, and very distinct from the fibrous vessels, and the cells containing their respective juices; and if the section be put under water, air is seen to issue from them.

There are cases when the elastic fluid in these vessels cannot have been obtained from the atmosphere, as in the *caulinea fragilis*, which grows under water. The author thinks it possible that the small crowns discovered in the interior of the sap vessels, may, perhaps, be the organs by which the air is in these cases separated from the water.

It is a constant law, in the general system of vessels, that those which are fibrous surround those which are aëriform. In ligneous plants nature has substituted other channels for the intercellular pas-

sages found in the herbaceous plants, these are the medullary rays of which an example is offered by the hemp, which may be seen by three sections, one transverse, one down the axis of the plant, and a third parellel to it, but on one side. The *asclapias syriaca* offers a similar structure.

M. Amici believes that in all vegetables, water and their own fluids pass into the vessels through pores in their respective membranes, which the eye cannot discover, but which many facts prove to exist. He affirms the integrity of the vessels during the whole existence of the plant, and denies any change in their nature. As to the question whether the spirals of trachæ are themselves tubular, and conduct sap, he thinks it undeterminable until the optical means we possess, are such as to develop the structure of the vegetable membrane, for the dimensions of the spiral of the trachæ does not exceed the thickness of the membrane of the other tubes, in which as yet no one has found vessels containing fluids.

2. *Dry Rot.* We have been favoured by Mr. Baker of Hampstead, with some valuable observations on the above subject, which want of room prevents our publishing in detail. He adduces a number of instances, in which the following application effectually prevented the disease, and cured it where it had made considerable ravages.

Take two ounces of white arsenic in powder, dissolve it by boiling in one gallon of soft water; if boiled in an iron or tinned vessel, add half an ounce of copper filings, but if in an untinned copper vessel the filings are not necessary; to a quart of size and half a pound of common tar, add a small quantity of fresh-slacked stone-lime, sifted pretty fine, beat them well into a paste, which should be then nicely dissolved with the above solution, gradually adding during the process (by small portions,) as much more of the pulverized lime as will give the whole a proper (rather diluted) body, to be laid on with a painter's brush. New work when finished as a preventative should be dressed with the composition, at least twice after well drying the first coat; old work as a curative when removed and repaired, (such as diseased wainscott) should be perfectly dried by exposition to the air, and then well dressed on its back before it is returned to its place.

3. *Insects in Amber.*—M. Schweigger having very attentively examined the insects contained in the bits of yellow amber of the coasts of Prussia, and which at first sight might be thought to be the same as the present insects of that country, has found that they in fact often belong to the same genera, but not to the same species as those living in the present day. Among the small number of insects described and figured in the work of this author, we observe in particular an unknown species of scorpion, and a spider which differs from all the

species living at present, in not having the head of a single piece with the thorax. M. Germar, professor, at Halle, has given the result of a similar investigation in an Entomological Journal, where he tries to determine some species of those amber insects, the analogies of which are not found alive at the present day.—*Edin. Journ.* ix. 408.

4. *Analyses by M. Arfwedson.*—Cinnamon stone of Malsjö:

Silica	41.87
Alumina	20.57
Lime	33.94
Oxide of Iron	3.93
Oxide manganese and magnesia	.39
	100.70

Brazilian chrysoberyl-Alumina	81.43
Silica	18.73
	100.16

Boracite from Lüneburg-boracic acid	69.7
Magnesia	30.3
	100.0

Borax, deprived of its water of crystallization, consists of

Boracic acid	68.9
Soda	31.1
	100.0

The borates were analyzed by being mixed with three or four times their weight of finely-powdered fluor spar free from silica, and a sufficient quantity of sulphuric acid; on evaporating the mixture and exposing it to a red heat, all the boracic acid was expelled as fluoboric acid gas. The quantity of base was then determined in the usual way.

5. *Loose Crystals in a Cavity in Quartz.*—Dr. Brewster has remarked the existence of a group of moveable crystals of carbonate of lime lying in a fluid in a cavity of a quartz crystal from Quebec, now in the collection of Mr. Allan. The crystal was perfectly sound about the cavity, which was of a triangular form, one side being about the tenth of an inch long. The fluid was transparent, and as it did not expand much by heat, was probably water. The crystals were transparent to a considerable degree, and had a white milky tint when viewed by reflected light. Their composition is inferred from the presence of

similar crystals in other speciments of quartz, which have been ascertained by experiment to be carbonate of lime. Some years ago Dr. Brewster had occasion to remark the existence of spherical groups of white crystals, both in the solid mass of quartz crystal from Quebec, and in cavities in them; these exactly resembled the crystals in Mr. Allan's specimen, and when analyzed, were found to be calcareous spar.—*Edin. Jour.* ix. 268.

6. *Chloride of Potassium.*—Mr. Smithson, on examining a mass said to have been thrown out of Vesuvius, found it to be a red ferruginous spongy lava, with here and there a crystal of augite, pyroxine, or hornblende, and containing veins of a white crystalline matter, which, on examination, proved to be chloride of potassium. Mr. Smithson supposes this substance to have been sublimed into the lava.—*Ann. Phil. N. S.* vi. 258.

7. *Chlorine a Remedy in Scarlet Fever.*—Dr. Brown employs chlorine in solution in cases of the scarlet fever, he says with the utmost success. From a tea-spoonful to a table-spoonful is given every two or three hours, without the addition of any other substance. The solution should be fresh and swallowed quickly to avoid coughing; in the sore throat sometimes accompanying the fever, it is more easily swallowed than mucilaginous drinks. As the disease declines, the quantity of medicine is diminished: the whole quantity in the cases of children has never exceeded two ounces, and in adults five ounces.

8. *Effects of the Chloride of Lime as a Disinfector.*—MM. Orfila Leseure, Gerdy and Hennelle, having to examine the body of an individual who was supposed to have been poisoned, and who had been dead for nearly a month, found the smell so insupportable that they were induced to try the application of the chloride of lime, as recommended by M. Labarraque. A solution of this substance was frequently sprinkled over the body, and produced quite a wonderful effect, for scarcely had they made a few aspersions when the unpleasant odour was instantly destroyed, and the operation could be proceeded in with comparative comfort.

9. *Use of Sugar as an Antidote to Lead in Cases of Poisoning.*—The following fact has been stated by M. Reynard to the Société des Sciences of Lisle. During the campaign of Russia several loaves of sugar had been enclosed in a chest containing some flasks of extract of lead. One of these flasks having been broken, the liquid escaped, and the sugar became impregnated with it. During the distresses of the campaign it was necessary to have recourse to this sugar; but far from producing the fatal results which were expected, the sugar formed a salutary article of nourishment to those who made use of it,

and gave them a degree of vigour and activity which was of the greatest service in enabling them to support the fatigues of marching. Hence M. Reynard thinks that sugar might be adopted for preventing the effects of subacetate of lead, instead of the sulphates of soda, and of magnesia, which are not always at hand.—*Med. Rep.* xx. 441, or *Journal d'Agriculture*, &c.

10. *Volcanic Eruption in Iceland.*—On the 22d of June last, a great noise began in Myrdals Jokel, on the south side of Iceland, and on the 26th there was a dreadful volcanic eruption from the Crater Kotlugian, which had been quiet since 1775. Pumice and ashes were thrown to a great distance, and even covered ships that were 90 miles from the coast. The ice on the summit of the mountain was torn asunder, prodigious masses rolled into the sea, while torrents of water thrown from the crater covered the adjacent country with mud and slime. There were three distinct eruptions, since which the mountain has been tranquil. This new volcano lies from six to eight leagues to the east of Eyafalle Jokel, which broke out in December last, and about twelve leagues south-east of Hecla.

11. *Periodical Rise and Fall of the Barometer.*—Colonel Wright, member of the Ceylon Literary and Agricultural Society, is said to have discovered that within the tropics, the mercury rises and falls twice within the twenty-four hours, with such regularity as to afford almost an opportunity of measuring the lapse of time by this instrument.

12. *Periodical Thunder Storms.*—Mr. Ronalds has quoted the curious remarks of Volta on the re-appearance of thunder storms for many days together, at the same hour and in the same place. "It is necessary to inhabit a mountainous country, and particularly the neighbourhood of lakes, such as Como, the precincts of Lario, Verbano, Varese, Lugano, Lecco, and the whole mountains of Bianza, Bergama, &c., in order to be convinced of such periods and fixations (so to speak) of thunder storms at this or that valley or opening of a mountain, which last until some wind or remarkable change in the atmosphere shall occur to destroy them." Volta ascribes the effect to a state of the atmosphere produced by the storms of the preceding day.

13. *Voyage of Discovery.*—Capt. Otto von Kotzebue is again about to circumnavigate the world, having already been twice round it. The present expedition is appointed by the Russian government, and is well furnished with every thing that can promote its object. The object is rather to make accurate surveys than new discoveries, but an astronomer, mineralogist, and naturalist, from the University of Dorpat go with it, as well as other scientific men. The instruments are by Troughton and Jones, of London.

14. *Animalculæ of Conferva Comoïdes.*—M. Bose read a report to the Royal Academy of Sciences, in the name of a commission, of a Memoir of M. Gaillon, of Dieppe, relative to that species of marine conferva which M. Decandolle has ranged in the genera *ceramion*, and which Dillwyn has figured under the name of *Conferva Comoides*.

M. Gaillon having observed at very short intervals for a whole year the filaments of the Conferva Comoide saw the green corpuscules, which are sometimes ovoide and sometimes square, and which form the central line, leave the filaments of themselves, move slowly or rapidly, change their direction, and act indeed like the animalcula of infusions, observed by Muller. Then taking entire filaments of the conferva comoïde, he forced the animalculæ to separate before their time, and observed the same phenomenon. Such is the necessity of association, that as soon as the young ones can, they place themselves end to end in a line, and then exude a mucus, which, becoming membranous, envelopes them entirely. The bifurcations are formed in the same manner.—*Ann. de Chimie*, xxiv. 208.

LITERARY NOTICES.

Mr. John Curtis has in the press the first No. of his Illustrations of English Insects. We understand the intention of the author is to publish highly-finished figures of such species of insects (with the plants upon which they are found,) as constitute the British genera, with accurate representations of the parts on which the characters are founded, and descriptive letter-press to each plate, giving, as far as possible, the habits and economy of the subjects selected. The work will be published monthly, to commence the first of January, 1824.

Mr. Frost intends publishing a Quarterly Botanical Journal, with occasional plates.

A geographical, statistical, and historical description of the Empire of China, and its Dependencies: by Julius Klaproth, member of the Asiatic Societies of London and Paris; of the Royal Society of Gottingen; of the Imperial Society of Naturalists, in Moscow; is preparing for publication, in 2 vols., quarto.

ART. XIX.—METEOROLOGICAL DIARY for the Months of September, October and November, 1823, kept at EARL SPENCER's Seat at Althorp, in Northamptonshire.

The Thermometer hangs in a North-eastern Aspect, about five feet from the ground, and a foot from the wall.

For September, 1823.

		Thermometer.		Barometer.		Wind.	
		Low.	High	Morn.	Eve.	Morn.	Eve.
Monday	1	48	70	30.09	30.03	W	WbS
Tuesday	2	53	69	29.95	29.89	W	W
Wednesday	3	48	66	29.90	29.97	W	W
Thursday	4	54	73	30.04	30.01	W	SW
Friday	5	51	72	30.00	30.01	SW	WNW
Saturday	6	46	64	30.05	30.02	NW	NNW
Sunday	7	45	63	30.10	30.11	ENE	E
Monday	8	39.5	59	30.19	30.17	NE	NE
Tuesday	9	32.5	60	30.16	30.10	NNE	NW
Wednesday	10	35	68	30.10	30.10	NW	E
Thursday	11	41	65	30.18	30.10	E	E
Friday	12	40	67	30.05	29.58	E	S
Saturday	13	52	70	29.30	29.63	WbS	SW
Sunday	14	60	70	29.62	29.48	S	SW
Monday	15	58	65	29.28	29.50	WSW	W
Tuesday	16	46	66	29.66	29.77	WbS	SW
Wednesday	17	52	64	29.73	29.90	S	SW
Thursday	18	39	62	30.23	30.23	NW	WbN
Friday	19	35	60	30.16	30.04	SW	SW
Saturday	20	44	61	30.06	29.98	WbN	WbN
Sunday	21	46	58	29.78	29.44	W	SW
Monday	22	47	58	29.20	29.50	SW	WbN
Tuesday	23	39	60	29.79	29.80	WNW	SW
Wednesday	24	50	69	29.74	29.78	W	W
Thursday	25	54	65	29.84	29.83	W	WSW
Friday	26	51	68	29.73	29.79	W	WbN
Saturday	27	39	59	29.70	29.72	W	W
Sunday	28	35	57	29.80	29.87	W	NNW
Monday	29	30	57	29.90	29.79	EbN	ESE
Tuesday	30	34	50	29.22	29.16	S	SW

For October, 1823.

		Thermometer.		Barometer.		Wind.	
		Low	High	Morn.	Eve.	Morn.	Eve.
Wednesday	1	41	44	28.80	28.96	N	WSW
Thursday	2	33	53	29.30	29.45	W	W
Friday	3	31.5	57	29.70	29.70	W	S
Saturday	4	39	58	29.88	29.68	W	WNW
Sunday	5	35	58	29.96	29.87	SSE	SSE
Monday	6	54	62	29.72	29.70	SSE	WSW
Tuesday	7	45	59	29.91	29.93	W	W
Wednesday	8	33	57	29.98	29.79	W	SbW
Thursday	9	45	56	29.43	29.40	SW	SW
Friday	10	34	52	29.32	29.20	SW	SW
Saturday	11	41	51	28.80	29.02	WbS	SW
Sunday	12	34	51.5	29.09	29.20	W	SW
Monday	13	37	52	29.20	29.27	ESE	E
Tuesday	14	31	52	29.37	29.37	NW	NW
Wednesday	15	30	51	29.32	29.32	WbS	W
Thursday	16	41	54	29.43	29.48	W	W
Friday	17	36	52	29.48	29.45	WbS	SW
Saturday	18	35	53	29.40	29.39	SW	ESE
Sunday	19	30	57	29.53	29.64	E	ENE
Monday	20	59	60	29.40	29.95	SE	ESE
Tuesday	21	50	55	29.95	30.12	E	E
Wednesday	22	45	51	30.09	30.00	NE	EbN
Thursday	23	40	53	29.85	29.85	E	E
Friday	24	39	54	29.90	29.94	ENE	E
Saturday	25	34	50	30.12	30.20	N	NE
Sunday	26	43	47	30.30	30.20	SW	W
Monday	27	45	50	30.12	30.00	W	WSW
Tuesday	28	41	52	29.70	29.50	SW	SW
Wednesday	29	39	46.5	29.50	29.50	SW	WSW
Thursday	30	40	42	29.22	29.08	E	EbN
Friday	31	36	39	29.08	29.28	NE	NE

For November, 1823.

		Thermometer.		Barometer.		Wind.	
		Low	High	Morn.	Eve.	Morn.	Eve.
Saturday	1	36	41	29.70	29.78	NNE	NW
Sunday	2	27.5	39	29.96	29.96	NW	NW
Monday	3	27	48	29.85	29.73	W	SW
Tuesday	4	46	48	29.48	29.37	S	S
Wednesday	5	43	46	29.50	29.49	WS	E
Thursday	6	46	53	29.73	29.77	SE	EbS
Friday	7	47	54	29.80	29.83	W	NW
Saturday	8	42	49	30.03	30.10	WNW	NE
Sunday	9	42	48	30.26	30.26	NE	ENE
Monday	10	34	45	30.36	30.40	ENE	EbN
Tuesday	11	26.5	41	30.44	30.40	ESE	NW
Wednesday	12	24	37	30.32	30.28	NW	SW
Thursday	13	23	40	30.26	30.32	SW	SW
Friday	14	28	46	30.20	30.08	WbS	WSW
Saturday	15	42	47	30.10	30.12	WbN	NW
Sunday	16	35	41	30.26	30.25	W	W
Monday	17	39	43	30.23	30.20	NW	NNW
Tuesday	18	42	46	30.28	30.28	NE	E
Wednesday	19	41	46	30.07	29.94	E	SW
Thursday	20	40	49	29.67	29.87	SW	W
Friday	21	42	48	30.00	29.93	W	WbS
Saturday	22	42.5	47	29.82	29.75	SW	SW
Sunday	23	43	49	29.80	29.80	SW	WSW
Monday	24	46	49	29.84	29.89	SW	WbS
Tuesday	25	41	50	30.03	30.06	W	SW
Wednesday	26	45	47	30.03	30.03	SW	SW
Thursday	27	45	46	30.03	29.98	SW	SW
Friday	28	44	45.5	29.86	29.78	SW	S
Saturday	29	45	52	29.51	29.30	S	SW
Sunday	30	47	54	29.28	29.24	S	SW

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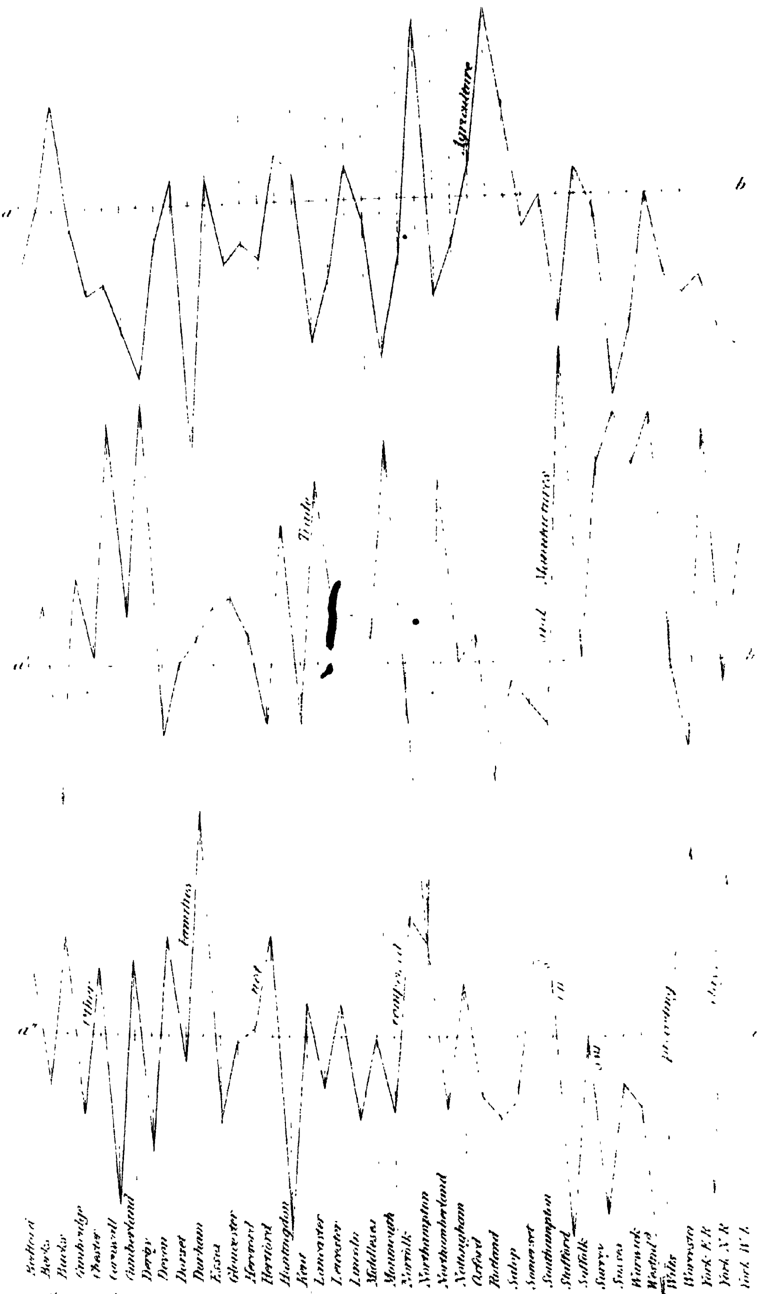

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Fig. 1.

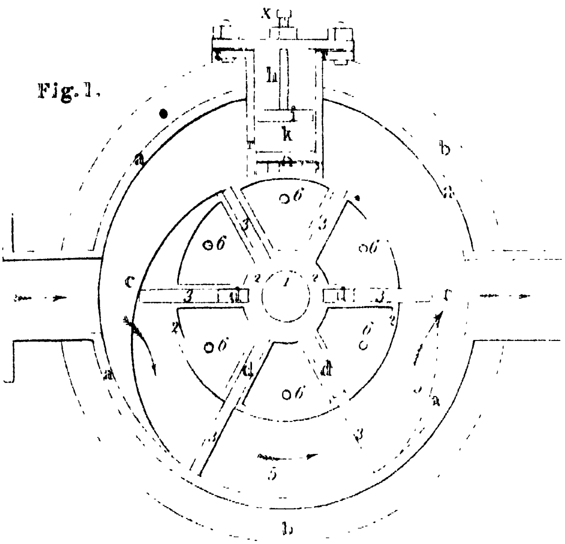

Fig. 2.